RESEARCH METHODOLOGY AND SCIENTIFIC WRITING

Scientific Literature, Proposal Development, and Manuscript Writing

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Preface

The book on Research Methodology and Scientific Writing has been produced to assist and provide guidelines for undergraduate students who have little experience or knowledge in conducting research and for a postgraduate student who is relatively new to writing and publishing scientific papers. However, the book can also be used as a reference for professionals /researchers who would like to publish scientific papers.

The book comprises sections about scientific literature, science and the scientific method, characteristics and classification of research, research problem identification, proposal development, ways of evaluating and writing a literature review, ways of communicating research findings, manuscript preparation for publication, and research ethics. Furthermore, the book contains activities along with a discussion of the activities and unit exercises with their answers. References and further reading materials are also included in each unit.

After reading the book, undertaking the exercises and reading the discussion of the exercises, readers should be able to:

- Understand the nature and purpose of different types of scientific literature
- Conduct a literature search
- Identify sources of information available in their countries/ local areas
- Make attempts at critical evaluation of research-based books, articles, reports and other publications
- Demonstrate the knowledge and skills of scientific writing
- Understand the meaning of science, scientific research, and the scientific method

1.1. Introduction to Scientific Literature

One of the most valuable tools for researchers beginning research in Chemistry is the chemical literature. It provides information on the methodology and experimental results of previous and current investigations. It can also be used to obtain an introduction or overview for an unfamiliar topic. Moreover, the researcher, by conducting a thorough search of the literature may avoid unnecessary duplication of research which has already been published. Much time and effort can be saved by consulting chemical literature before the experimental work is started. In general, the scientific literature is designed to be a reliable archive of scientific research, providing a growing, stable base for new research investigations. When researchers present their new ideas and results to the community, they are expected to support their ideas with knowledge of the scientific literature and the work that has come before them. That means, researchers are, in fact, obligated to provide details about where they got the information to conduct scientific research. In short, the scientific literature is of central importance to the growth and development of science as a whole.

Science is a cumulative process, with each experiment building on those that preceded it. A researcher must be able to determine what has already been done, how it was done, plus factual data about chemicals, procedures, instruments, and so forth. This implies that researchers must know how to find and use information. So, this unit is intended to be general enough to be useful in any area of chemistry as it gives a reader a basic overview of the scope and natures of scientific literature; the major resources in the chemical literature and how and why to use them; how to find scientific information and criteria to evaluate information sources.

1.2. Unit Objectives

At the end of this unit, the student should be able to:

- Describe the nature and purpose of scientific literature
- Differentiate between primary and secondary sources of literature
- Distinguish the various types of scientific literature
- Explain the general nature of the peer-review process
- Enumerate the various types of information sources
- Perform a literature search using different databases (print and electronic)
- Develop an organized plan for gathering information on a particular topic
- State fundamental criteria for evaluating sources in order to choose the right one

1.3. Scientific Literature

Science is an ongoing, cyclical process that builds upon past discoveries to create new knowledge. The past informs the present, which in turn determines the future. Researchers learn all they can about a specific topic or area of study by first consulting the more general tertiary and secondary literature sources, then proceeding to the primary literature sources. This, in turn, led to the discovery of new knowledge that moves through the primary literature, then eventually into secondary and tertiary forms of literature. Thus, using and publishing scientific literature is an ongoing, iterative process for all researchers.

In its earliest stages, the scientific literature took the form of letters, books, and other writings produced and published by individuals for the purpose of sharing their research. Today, although researchers still publish books and letters, the vast majority of the scientific literature is published in the form of journal articles, a practice that started

the mid-1600s. As the number of scientific journals expanded, they helped to promote the progress of science itself. Today, there are lots of scientific journals and publishers that publish research articles as well as abstracts or short summaries of scientific research articles.

As a result, many researchers were encouraged to take up the study of science and publish their own research. This, in turn, led to an explosion in the number of scientific studies that were conducted and the resulting knowledge that was generated from this research.

Activity 1.1

a. Define scientific literature.

b. List the three categories of scientific literature and provide examples for each category.

1.4. Kinds of Scientific Literature

Scientific literature sources are generally categorized as primary, secondary, or tertiary.

Primary literature

Primary sources are those where one finds original data. In an academic setting, you will usually find original information in a peer-reviewed journal; however other sources exist such as technical reports, conference proceedings, patents, dissertations (PhD thesis), theses (Masters), monographic series, and grant reports.

Secondary literature

Secondary sources will contain information derived from primary sources. It will be less complete than the primary source, but may nonetheless contain the information you seek. Whenever possible you should consult the primary source to verify the data you extract. There is more diversity of secondary sources than primary sources. Examples of secondary sources include review articles, indexing, and abstracting journals, textbooks, manuals, treaties and

monographs, handbooks, dictionaries, and encyclopedias. They can provide general background information to help narrow or broaden the focus of a topic, define unfamiliar terms, and offer bibliographies of other sources. These sources are especially useful during the writing phase of your research.

Tertiary literature

Examples of tertiary sources include chemical catalogs (Aldrich, Lancaster, etc.), guides, and material safety data sheets (MSDS). Chemical catalogs are increasingly useful sources of chemical data such as melting points and refractive indices.

Guides to handling hazardous materials, guides to disposal of chemical substances, laboratory safety guide, etc., can also be used as a source of information about chemicals. Material safety data sheets (MSDS) can also be used as a source of information about chemicals.

1.4.1. Scientific Journals

A scientific journal can be defined as "a periodical, especially the one containing scholarly articles and /or disseminating current information on research and development in a particular subject field." Researchers publish their original research findings in scientific journals primarily as a means of facilitating dissemination of their work to as wide an audience as possible. Scientific journals offer readers an aggregated collection of current research in the field of interest, with peer-review systems ensuring that articles are reputable. It also ensures that readers become aware of current research and methodology in their fields, preventing duplication of experiments, and raising awareness of new techniques. There are thousands of scientific journals that publish research articles. These journals are diverse and can be distinguished according to the field of specialization. For example: Science and Nature publish articles covering in all areas of science ; Journal of the American Chemical Society, physical review letters etc., publish articles covering all of

a major section of science, such as chemistry, biology or geology, Journal of Organic Chemistry, Inorganic chemistry, Analytical Chemistry etc., publish articles covering a major subsection of science, such as organic chemistry, inorganic chemistry and analytical chemistry respectively; Biogeochemistry, Nano Letters, Crystal Growth and Design, etc., publish articles covering a highly specialized area of research.

1.4.1.1. Types of scientific journal articles

There are three main types of journal articles. These are:

Full-length articles

The majority of research articles published fall into this category. These articles contain a comprehensive investigation of the subject matter. It describes in complete detail a specific research project or experiment, with full experimental details, methods, results, and a conclusion. For example Journal of the American Chemical Society, Journal of Analytical Chemistry, The Analyst, Perkin Transactions, Tetrahedron, etc., publish full-length articles.

Short communications (also called brief communications or letters)

These are shorter articles that provide a brief summary of work in progress and report interesting preliminary results. They are not as comprehensive in scope as full-length research articles, but nevertheless, contain information that makes a significant contribution to the literature. As the name implies, these articles can be published much faster than full articles, which may sometimes take many months in the editorial process. The purpose of publishing rapid communications is to establish one's priority in a specific line of inquiry. Further results are usually published in full papers later on. For example, chemical communications, organic letters, rapid communications in mass spectrometry, etc., publish short

Review articles

Review articles do not report new research findings, but rather summarize and synthesize recent research on a particular topic, usually over a specified chronological range. They are a good place to get a basic idea about a topic because reviews typically contain extensive bibliographies of recent and important articles. For example, Chemical Reviews and Critical Reviews in Analytical Chemistry, Accounts of Chemical Research, Chemical Society Reviews, Chemical Reviews, etc., publish major reviews.

Activity 1.2

a. What is a scientific journal?

b. Write the merits of scientific journals?

c. List the types of journal articles including their major sections.

1.4.1.2. Structure of Journal Articles

The structure of journal articles will vary with the type of articles. The structures of the three types of journal articles are presented below.

Structure of full-length research article

A typical full-length research article includes the following sections:

- Bibliographic information (article title, authors, author addresses)
- Abstract (include keywords)
- Introduction
- Materials and Methods
- Results and Discussions
- Conclusions and Recommendations
- References
- Acknowledgments

Detail description of the above sections of full-length research articles is given in unit four.

Structure of a letters and communications

Letters and Communications are usually shorter and may omit some of the sections in the list above. They may contain a brief introduction, combined results/discussion, and no materials and methods sections.

Structure of review articles

Review articles summarize previously published research. So, it includes an introduction, body of the paper, conclusion and future directions and literature cited. A materials and methods sections and abstract is generally absent, but the references section can be huge. In general, the precise structures of a journal article required will vary somewhat from journal to journal; nearly all use an "Instructions to Authors" section to inform prospective authors of their requirements, including the length of each type of article that is accepted, the length of the different sections, the maximum number of tables and figures, the abbreviations that can be used without defining them, the format for references in the text and in the bibliography, and other information on formatting your manuscript so that the journal will consider it for publication. Thus, authors should look at instructions to authors before writing journal articles.

1.4.1.3. Peer-review

The majority of scientific journals publish peer-reviewed articles, also called refereed articles. Peer-reviewed articles undergo a process called peer-review in which other scientists (the professional peers of the authors) evaluate the quality and merit of research before recommending whether to accept the article as it is, send it back to the author for revision, or reject it outright.

So, peer-review is a much lengthier and more rigorous process by which articles submitted to a journal are evaluated by experts

in that field. The reason for this thorough evaluation by peers is that a scientific article is more than a snapshot of what is going on at a certain time in a researcher's research. Instead, it is a part of what is collectively called the scientific literature, a global archive of scientific knowledge. When published, each article expands the library of scientific literature available to all scientists and contributes to the overall knowledge base of the discipline of science.

1.4.2. Conference Papers

A conference paper is an original contribution that was presented orally or in the form of a poster at scientific meetings. Papers presented at a conference are often the fastest way of publishing hot new information. Conference organizers may bring out reports and compilations of conference papers in several forms, such as conference proceedings. It can be very useful, by bringing together much up to date and relevant information in a particular field. However, a print version of conference papers are often hard to get; indexing can be slow, and they are not refereed in most cases.

1.4.3. Technical Reports

Technical reports are an outgrowth of an institution (government-funded) research. Some technical reports present research as ongoing, rather than completed work, along with more comprehensive reporting of results. In addition, some institutions publish working papers or research reports on interim or final results for internal review and evaluation prior to attempts to publish in wider, in particular international, journals. They often have information (primary data) before it appears in journal form but they are not peer-reviewed. Sometimes they contain data which appears nowhere else. They are often difficult to obtain, but if they are the only source of information, they should be cited like books.

1.4.4. Dissertations and Theses

Dissertations and theses are documents presented by students in pursuit of a master's or doctoral degree, respectively. They are major forms of academic publication and often contain information,

especially experimental detail, not reported elsewhere, or reported much later. Thus, they can be useful sources of information. However, they are difficult to obtain since they are not published.

1.4.5. Books

In sciences, books (also called monographs) may be entirely written by one or more authors, but just as often they are collections of chapters by various authors assembled by an editor. Books do not report new research results; they serve instead as a summary of current knowledge and recent progress and cover a topic more broadly than journal articles do. Books, therefore, are largely built around findings that have become accepted (overtime) by the scientific community. As such they fall into the category of secondary literature and can be regarded as reviews. Textbooks are written especially for students and present well-established information in a pedagogical sequence for the purposes of teaching, with plentiful illustrations, examples, and exercise questions. A book can also be a thesis or dissertation.

1.4.6. Handbooks

Handbooks collect frequently-needed information in a concise, organized format. Some are compilations of factual data in table form. Others are more textual and summarize key techniques and methodologies. Use a handbook's index to look up a property name, technique, or concept.

1.4.7. Encyclopaedias

Encyclopedia articles are written by experts. They are intended for an intelligent audience of non-experts. They usually contain a bibliography for Further readings. There are a number of excellent encyclopedias covering chemistry. For instance, Encyclopedia of analytical chemistry: Extensive compilation of articles on all types of chemical analysis and instrumentation for all types of analytics and matrices. It is divided into five volumes on theory and instrumentation, and ten volumes on applications.

1.4.8. Works of Reference

They are useful to begin a research project. Some of the reference works that provide information includes indexes, abstracts, and bibliographies.

Index: A tool which provides access to the content of the journal literature (articles) by a "pointer" derived from the original. Examples of pointers: author names, subject terms, chemical formulas, etc. Indexing publications such as Current Contents and Chemical Titles index a vast array of scientific publications (journals, books, conference proceedings, etc.). However, in recent years their significance has declined as the same information is frequently available online. Science Citation Index is the first citation index for scientific scholarly journals. It makes use of the inherent linking characteristics of scientific papers: a single scientific paper contains citations to any number of earlier studies on which that work builds, and eventually it too is cited by future research studies. Thus, when you find a reference that is relevant; you can look up other papers that cite it as well. This is particularly useful when trying to see how a certain bit of research was expanded upon. In chemistry, Chemical Abstracts (CA) is the primary indexing source available in electronic format on the Web. It's one of the largest and most comprehensive indexes in the world. It is a good place to start literature searching because it includes records from almost all of the core journals in chemistry, chemical engineering, polymer science, and biomedicine, back to 1967. There are different options for access to Chemical Abstracts.

Abstract: A brief summary of the content of a document (journal articles, conference papers, patents, review articles, etc.). Abstracts will help you to identify which articles, books, and reports are most relevant and worth obtaining. The documents obtained may provide further references that can be followed up. In chemistry, Chemical Abstracts (CA) is the premier abstracting service available online. It began publication in 1907. If one wishes to search early in this

information resources available on the web are increasing. The Internet provides different types of resources. The common Internet resources are online references, online databases, commercial sites, educational sites, government sites, etc.

Online reference

The online reference is a general category that encompasses traditional print-based reference material found on the Internet in electronic format. Encyclopedias, dictionaries, journals, and newspapers are among the references that can commonly be found online. Research can be made much easier by using online reference material. Online reference material may either be available for free or there may be a nominal charge to access the material.

Online databases

Online databases are public databases that can be accessed on the Web. Online databases provide you access to a great depth of related information on topics, fields of research, news, and so on. Similar to other online reference resources, the information may or may not be available for free. You may need to register and obtain a member account to access a database.

Commercial sites

Researching various applications, vendors, and companies are vastly simplified using the Internet. Commercial sites, identified by .com in their Web address, contain a wide range of information. Some of this information may be suitable for research; however, you may find that much of the information is aimed at marketing and advertising. It is worth exploring these sites, partially because they may contain valuable information or links, but mostly because they are so prevalent that you will not be able to avoid them. For instance, most chemical companies and laboratory chemical supply firms provide at least basic data for the products they manufacture or sell on their Web site. It is common to find material safety data sheets (MSDS) and technical bulletins online. For example, technical

services, such as renewing a driver's license. Other sites provide access to archives and general laws.

Activity 1.4

a. List examples of electronic scientific literature resources.

b. Write ways of searching the scientific literature.

c. List common criteria to evaluate electronic resources.

1.7. Searching Scientific Literature

Researchers use both print resources and electronic resources to search and use the latest information in their respective fields and related ones. These information resources are increasingly available via the internet as well as in libraries particularly the academic library. This section presents some techniques you can use to find information quickly.

1.7.1. Academic Library

Libraries connect information seekers with the information they want in deliberate and organized methods. They are the place where different types of information resources in different formats (print, audio, video and digital) is gathered together so that people can sort through and find the specific items or knowledge they're looking for. In traditional libraries, various tools and guides to locate these resources are available only when a user physically visited the library. However, with the developments of computer-based databases and availability of online resources, libraries are designed to provide access not only to information printed on paper but also to a wide variety of electronic resources, including online catalogues, CD-ROM databases, online databases, and electronic journals and books, and internet and hence they provide access to the newest electronic forms of scientific communication, which forms an integral part of modern libraries.

conferences? Has he or she written other papers on the t
These are some ways to determine an author's credib
You may also think of other ways.

- **Common sense and instinct:** Step back and perform
reality check. Follow your instincts. If you are uneasy abo
using a source of data, even after employing some of th
strategies discussed, do not use it.

1.9. Unit Summary

- The scientific literature provides an archive of research which the researcher makes use of throughout the process of investigation.
- New research questions can be investigated by reanalyzing or compiling data from the literature.
- There are different types of scientific kinds of literature including journal articles, conference proceedings, dissertations and theses, monographs, handbooks, encyclopedias and dictionaries, and technical reports, etc., organized into primary, secondary and tertiary documents.
- Scientific journals are reviewed by several peer scientists who are familiar with the field of research and who make recommendations on whether or not the work should be published.
- Scientists make their research available to the community either by publishing it in paper or posted on the internet.
- Internet and academic library are important sites a great place for looking up information but critical evaluation of sources is essential.

1.10. References/ Further readings

- Antony A (1979). Guide to Basic Information Sources in Chemistry. Wiley, New York, 1979.

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organized into primary, secondary and tertiary documents.
- Scientific journals are reviewed by several peer scientists
who are familiar with the field of research and who make
recommendations on whether or not the work should be
published.
- Scientists make their research available to the community
either by publishing it in paper or posted on the internet.
- Internet and academic library are important sites a great
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1.11. Unit Exercise

1. Which one of the following is a source of information to conc scientific research?

   a) Journal articles
   b) Conference proceedings
   c) Dissertation and theses
   d) Technical reports
   c) All of the above.

2. Which one of the following is a reference work that provide data about research materials?

   a) Indexes
   b) Bibliographies
   c) Collection of abstracts
   d) A and B only.
   e) All of the above.

3. Which of the following statements is false about review journa articles?

   a) Synthesis and summarize recent research on a particular topic.
   b) Contain extensive bibliographies of recent and important articles.
   c) Good place to get a basic idea about a topic.
   d) They report new research findings.
   e) None of the above.

4. Which one of the following is a way of searching online reference databases?

   a) Author search
   b) Title search
   c) Subject search
   d) Keyword search
   e) All of the above.

5. Which technique would be most helpful in validating potentially biased information?

a) Research the author's credentials
b) Check the publication date of the information
c) Use your common sense and instinct
d) Look for similar information in other sources
e) All of the above.

6. Which of the following scientific literature contains new research findings?

a) Peer-reviewed journal
b) Technical reports and Patents
c) Conference proceedings
d) Dissertations (Ph. D) and theses
e) All of the above.

7. Which one of the following is a source of literature?

a) Libraries
b) Internet
c) CD-ROM
d) a and b only
e) All of the above.

UNIT TWO

SCIENTIFIC METHOD AND RESEARCH

2.1. Introduction to Research

Most people are engaged in some form of research in their daily lives. Everyone describes events, explains what causes these events, predicts the future occurrence of these events, proposes solutions and learns how to control these events to his/her own advantage. So, everyone has the capacity to do research. The fundamental requirement for research is an enquiring mind in order to recognize that there are questions that need answers.

Research may be defined as a careful study or investigation in order to discover new facts or information. It involves a process of asking questions and answering them by survey or experiment in an organized way. The main purpose of research work is based on finding facts and truth. Research can contribute a lot to the society, institution or a country. The findings of the research are of substantial importance for planners, policymakers, and administrators.

For a clear perception of the term research, one should know the nature of science and the scientific method. The two terms, research, and the scientific method are closely related. Thus, the definitions of the following concepts: science, scientific research, scientific method, and theory, are crucial in order to understand the meaning and implication thereof for conducting research. So, this unit describes the nature of science and the scientific method before looking at an overview of the meaning of scientific research, characteristics of research and types of research.

2.2. Unit Objectives

At the end of this unit, you should be able to:

- Familiarize with the nature of science
- Identify the steps that are followed in the scientific method
- Define hypotheses, theory, and law
- Differentiate between a hypothesis and a theory
- List the characteristics of a hypothesis
- Differentiate between independent and dependent variables
- Explain the characteristics of the scientific methods
- Define research in general and scientific research in particular
- Explain the purpose of research
- Identify the different types of research
- Discuss the characteristics of scientific research
- List the steps involved in the research process

2.3. The Nature of Science and the Scientific Method

Science is a methodical approach to studying the natural world. Does Science ask basic questions, such as how does the world work? How did the world come to be? What was the world like in the past, what is it like now, and what will it be like in the future? These questions are answered using observation, testing, and interpretation through logic. Most scientists would not say that science leads to an understanding of the truth. Science is a determination of what is most likely to be correct at the current time with the evidence at our disposal.

Scientific explanations can be inferred from confirmable data only, and observations and experiments must be reproducible and verifiable by other individuals. In other words, good science is based on information that can be measured or seen and verified by other

scientists. Things that are not testable or falsifiable in some scientific or mathematical way, now or in the future, are not considered science. Falsifiability is the principle that a proposition or theory cannot be scientific if it does not admit the possibility of being shown false. Science takes the whole universe and any and all phenomena in the natural world under its purview, limited only by what is feasible to study given our current physical and fiscal limitations. Anything that cannot be observed or measured or shown to be false is not amenable to scientific investigation. Explanations that cannot be based on empirical evidence are not a part of science (National Academy of Sciences, 1998). Science is, however, a human endeavor and is subject to personal prejudices, misapprehensions, and bias. Over time, however, repeated reproduction and verification of observations and experimental results can overcome these weaknesses. That is one of the strengths of the scientific process.

Scientists formulate and test their explanations of nature using observation, experiments, and theoretical and mathematical models. Although all scientific ideas are tentative and subject to change and improvement in principle, for most major ideas in science, there is much experimental and observational confirmation. Those ideas are not likely to change greatly in the future. Scientists do and have changed their ideas about nature when they encounter new experimental evidence that does not match their existing explanations. (NSES, 1996, p. 171)

Activity 2.1

a. Define science and the scientific method.

2.3.1. The Scientific Method

The scientific method, it could be said, is a way of learning or a process of using comparative critical thinking. It is the result of recognizing that personal and cultural beliefs influence both our perceptions and our interpretations of natural phenomena. Rene Descartes established the framework of the scientific method in

1619, and his first step is seen as a guiding principle for many in the field of science today: By sticking to certain accepted "rules of reasoning," scientific method helps to minimize the influence on results by personal, social, or unreasonable influences. Thus, science is seen as a pathway to study phenomena in the world, based upon reproducible, testable and verifiable evidence. This pathway may take different forms; in fact, creative flexibility is essential to scientific thinking, so there is no single method that all scientists use, but each must ultimately have a conclusion that is testable and falsifiable; otherwise, it is not science.

The scientific method may include some or all of the following steps in one form or another: observation, defining a question or problem, research (planning, evaluating current evidence), forming a hypothesis, prediction from the hypothesis (deductive reasoning), experimentation (testing the hypothesis), evaluation and analysis, peer-review and evaluation, and publication. The simplified diagram shown in Figure. 1 illustrates the typical steps of the scientific method.

As depicted in the flowchart, the scientific method consists of making observations, formulating hypotheses, and designing experiments. A scientist may enter the cycle at any point and each step is described as follows:

Step 1: Observation

The first process in the scientific method involves the observation of a phenomenon, event, or "problem." The discovery of such a phenomenon may occur due to interest on the observer's part, a suggestion or assignment, or it may be an annoyance that one wishes to resolve. The discovery may even be by chance, although it is likely the observer would be in the right frame of mind to make the observation.

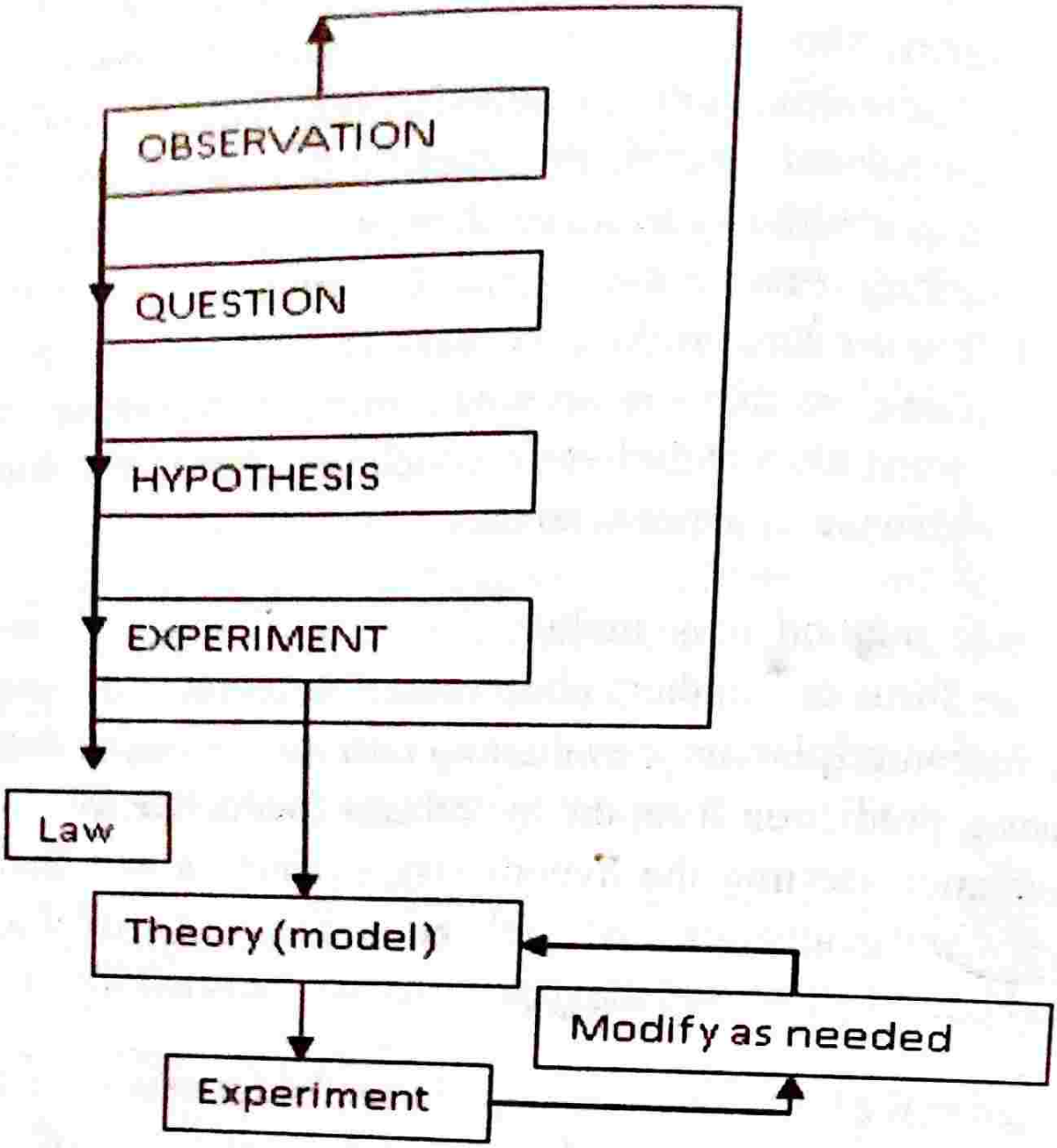

Figure 1: The scientific method

Step 2: Question

Observation leads to a question that needs to be answered to satisfy human curiosity about the observation, such as why or how this event happened or what it is like. In order to develop this question, observation may involve taking measures to quantify it in order to better describe it. Scientific questions need to be answerable and lead to the formation of a hypothesis about the problem.

Step 3: Hypothesis

A hypothesis is a tentative explanation or a scientific guess or predictive statement for an observation, phenomenon, or scientific

problem made by the researcher and which will be tested after data collection (or by further investigation). It predicts or explains relationships between two or more variables. Thus, to answer a question, a hypothesis will be formed. This is an **educated guess** regarding the question's answer. An educated guess is highlighted because no good hypothesis can be developed without research into the problem. Hypothesis development depends upon a careful characterization of the subject of the investigation. The literature on the subject must be researched, which is made all the easier these days by the Internet (although sources must be verified; preferably, a library database should be used).

Sometimes numerous working hypotheses may be used for a single subject, as long as research indicates they are all applicable. Hypotheses are generally consistent with existing knowledge and are conducive to further inquiry.

A scientific hypothesis has to be testable and also has to be falsifiable. In other words, there must be a way to try to make the hypothesis fail. Science is often more about proving a scientific statement wrong rather than right. If it does fail, another hypothesis may be tested, usually one that has taken into consideration the fact that the last tested hypothesis failed. One fascinating aspect is that hypotheses may fail at one time but be proven correct at a later date (usually with more advanced technology).

The hypothesis should also contain a prediction about its verifiability. For example, if the hypothesis is true, then (1) should happen when (2) is manipulated. The first blank (1) is the dependent variable (it depends on what you are doing in the second blank) and the second blank (2) is the independent variable (you manipulate it to get a reaction). There should be no other variables in the experiment that may affect the dependent variable.

Importance of hypotheses

- Hypotheses can advance knowledge by confirming or refuting theoretical positions from which they were derived.
- They suggest new observations and uncover facts.
- They link formal systems of logical reasoning to science. Hypotheses enable the researcher to focus the research on one or two variables.
- Hypotheses provide a statement of the relationship between variables in a manner that allows for empirical testing.
- Hypotheses provide data that are specific and facilitate their acceptance or rejection at the end of the study.

Characteristics of hypotheses

- A good hypothesis should be clear and concise. It should contain a few variables under investigation, usually two or more. The hypothesis should clearly predict or infer a causal relationship between the variables. Hypotheses are more applicable to explanatory and experimental studies.

Classification of types of hypotheses

- Hypotheses are classified into three major types – directional, non-directional and null or statistical hypotheses. The directional hypothesis: It is the hypothesis that specifies the expected direction of the relationship between the variables under study. The non-directional hypothesis: This is the hypothesis that does not specify the direction of the relationship, but predicts that a relationship exists between the variables, and does not indicate the nature of the relationship. The null or statistical hypothesis is the hypothesis of no difference and no relationship. Here, If your prediction was correct, then you would (usually) reject the null hypothesis and accept the alternative. If your original

prediction was not supported in the data, then you will accept the null hypothesis and reject the alternative. The alternative hypothesis is also called the research hypothesis.

One thing is clear about the requirement of the testability of hypotheses: it must exclude supernatural explanations. If the supernatural is defined as events or phenomena that cannot be perceived by natural or empirical senses, then they do not follow any natural rules or regularities and so cannot be scientifically tested. It would be difficult to test the speed of angels or the density of ghosts when they are not available in the natural world for scientific testing, although certain people have tried to determine if such entities are real and testable, and it cannot be precluded that someday technology may exist that can test certain "supernatural" phenomenon.

Step 4: Experiment

Once the hypothesis has been established, it is time to test it. The process of experimentation is what sets science apart from other disciplines, and it leads to discoveries every day. An experiment is designed to prove or disprove the hypothesis. Perhaps the most familiar way is to conduct a controlled experiment.

A controlled experiment tests only one factor at a time. A controlled experiment has a control group and one or more experimental groups. All the factors for the control and experimental groups are the same except for one factor, which is called the variable. By changing only one factor, you can see the results of just that one change. Sometimes, the nature of an investigation makes a controlled experiment impossible. For example, dinosaurs have been extinct for millions of years, and the Earth's core is surrounded by thousands of meters of rock. It would be difficult, if not impossible, to conduct controlled experiments on such things. Under such circumstances, a hypothesis may be tested by making detailed observations as well as using theoretical and mathematical models. Taking measurements is one way of making observations.

Note: With the rapid progress in electronics, computer simulations can now carry out some experiments.

Variables

A variable is any entity that can take on different values. Variables are of interest in research because they are the main reasons for the research. The variables that are of importance in research can further be grouped into independent and dependent variables. Variables are not restricted to preexisting attributes of humans, organisms, events or environment. The researcher could in many situations create or design a variable that is applicable to the purpose of the research.

Types of variables

Independent variable

- The independent variable is that variable in the research which the researcher manipulates, and could be equated to a cause or a stimulus or treatment in research that has to establish a cause-effect relationship.

Dependent variable

- It is that variable that is not manipulated by the researcher, but which the researcher expects will change once the independent variable is introduced. It can be equated to the effect, response or the result. For example, in a study to establish that student's performance in a Course of Human Biology is affected by the teaching method, the teaching method is the independent variable to be manipulated by the researcher. The students' result (performance) is the dependent variable.

Extraneous variable

controlled. These variables are called extraneous variables and must be controlled in any research. Other terms used by different authors to describe the extraneous variable include – confounding variable, interfering variable, intervening variable, contaminating variable. These must be controlled especially in experimental studies for them not to influence the results.

Testing and experimentation can occur in the laboratory, in the field, on the blackboard, or the computer. Results of testing must be reproducible and verifiable. The data should be available to determine if the interpretations are unbiased and free from prejudice. It is interesting that other scientists may start their own research and enter the process of one scientist's work at any stage. They might formulate their own hypothesis, or they might adopt the original hypothesis and deduce their own predictions.

Often, experiments are not done by the person who made the prediction, and the characterization is based on investigations done by someone else. Published results can also serve as a hypothesis predicting the reproducibility of those results.

Step 5: Analyze the Results

After you have completed your experiments, made your observations, and collected your data, you must analyze all the information you have gathered. Tables and graphs are often used in this step to organizing the data.

Step 6: Draw Conclusions

Based on the analysis of your data, you should conclude whether or not your results support your hypothesis. If your hypothesis is supported, you (or others) might want to repeat the observations or experiments to verify your results. If your hypothesis is not supported by the data, you may have to check your procedure for errors. You may even have to reject your hypothesis and make a new one. If you cannot draw a conclusion from your results, you may have to try the investigation again or carry out further observations or experiments.

Step 7: Evaluation

All evidence and conclusions must be analyzed to make sure bias or inadequate effort did not lead to incorrect conclusions. The qualitative and quantitative mathematical analysis may also be applied. Scientific explanations should always be made public, either in print or presented at scientific meetings. It should also be maintained that scientific explanations are tentative and subject to modification. Thus, evaluation is integral to the process of the scientific method. One cannot overemphasize the importance of peer-review to science, and the vigor with which it is carried out. Full-blown academic battles have been wagged in scientific journals, and in truth, many scientific papers submitted to peer-reviewed journals are rejected.

The evaluation process in science truly makes it necessary for scientists to be accurate, innovative, and comprehensive. In general, the scientific method of inquiry is characterized by the following convictions:

- That the process must be objective to reduce bias in methods and interpretation of results.
- That the process should be systematic in that it ought to involve certain standard procedures.
- An inquiry should be conducted through a process of systematic observation that can be verified by experience (empiricism).
- There should be careful recording, documenting, archival and sharing of all data and methodology (full disclosure) to make it available for scrutiny by other researchers, thereby allowing them to verify results by attempting to reproduce them.

The scientific method is not a "straight line" of steps. It contains loops in which several steps may be repeated over and over again, while others may not be necessary. For example, sometimes scientists will find that testing one hypothesis raises new questions and new

hypotheses to be tested. And sometimes, testing the hypothesis leads directly to a conclusion. Furthermore, the steps in the scientific method are not always used in the same order.

2.3.2. Scientific Theory

An integrated, comprehensive explanation of many facts, especially one that has been repeatedly tested or is widely accepted is known as a scientific theory and it can be used to make predictions about natural phenomena. A theory can often generate additional hypotheses and testable predictions. Theories can incorporate facts and laws and tested hypotheses. A scientific hypothesis that survives extensive experimental testing without being shown to be false becomes a scientific theory.

Accepted scientific theories also produce testable predictions that are successful. Theories are powerful tools. Scientists seek to develop theories that are firmly grounded in and based upon evidence; are logically consistent with other well-established principles; explain more than rival theories; have the potential to lead to new knowledge.

Scientific theories are falsifiable and can be re-evaluated or expanded based on new evidence. This is particularly important in concepts that involve past events, which cannot be tested. Take, for example, the Big Bang Theory or the Theory of Biological Evolution as it pertains to the past; both are theories that explain all of the facts so far gathered from the past but cannot be verified as absolute truth since we cannot go back to test them. More and more data will be gathered on each to either support or disprove them. The key force for change, in theory, is, of course, the scientific method.

Activity 2.2

a. Define research.

b. List the general purpose of research.

c. List the characteristics of research.

2.4. Definition/Meaning of Research

The word research is composed of two syllables, re and search. The dictionary defines the former as a prefix meaning again, a new or over again and the latter as a verb meaning to examine closely and carefully, to test and try, or to probe. Together, they form a noun describing a careful, systematic, patient study and investigation in some field of knowledge, undertaken to establish facts or principles. In another word, research is the orderly investigation of a subject matter for the purpose of adding to knowledge. '**Re**search' also implies that the subject matter is already known but, for one reason or another, needs to be studied again.

Alternatively, the expression can be used without a hyphen and in this case it typically means investigating a new problem or phenomenon. Research has been defined differently by different people. A few definitions are presented below followed by the key characteristics.

Research is a systematic, formal, rigorous and precise process employed to gain solutions to problems or to discover and interpret new facts and relationships (Waltz and Bausell, 1981). Research is the process of looking for a specific answer to a specific question in an organized, objective, reliable way (Payton, 1979). Kerlinger defines research as the systematic, controlled, empirical and critical investigation of natural phenomena guided by theory and hypotheses about the presumed relations among the natural phenomena. Research is the pursuit of truth with the help of study, observation, comparison, and experiment; the search for knowledge through an objective and systematic method of finding solutions to a problem (Kothari, 2006).

According to Webster's dictionary, research is diligent scientific search or inquiry to discover facts. The Wikipedia encyclopedia describes research as an active, diligent and systematic process of inquiry in order to discover, interpret or revise facts, events, behaviors or theories. When these definitions are consolidated, it can be said that research is the systematic activity directed towards objectively investigating specific problems in order to discover the relationships between and among variables. It seeks to answer specific questions.

The term scientific research implies that a disciplined method of thinking is followed about observed phenomena in order to arrive at a better understanding of the world in which we live. We notice and observe events daily. From observing and noticing events and their relation to other events we hold an opinion, make statements and have ideas about these events. It begins with basic questions or propositions about specific phenomena. This means scientific research is a way of thinking; it involves thinking about what we want to study, how we go about collecting data, analyzing the data and deriving conclusions.

Scientific research has no time reference. It seeks to discover natural laws that are uninfluenced by time (Mohsin, 1984:2). Scientific research starts with observation. The objective of such research is to use observation as a basis for answering a question of interest.

Scientific research tries to establish relationships among facts, means of logical and systematized methods, aims to discover new facts or old facts and to analyze their sequences, interrelationships, causal explanation's and the natural laws which govern them (Mukerji, 1985:1)

2.5. Objectives of Research

The purpose of the research is to investigate a research question through the application of scientific procedures with a view to generating knowledge. The research question you investigate will relate to a particular problem or issue that you identify from studying a particular topic. Research is much more than mere speculation

or assumptions about events, phenomena, and activities. It allows you to apply theory to or otherwise analyze a real problem, or to explore and analyze more general issues. It also enables you to apply techniques and procedures to illuminate the problem and contribute to our greater understanding of it or to generate solutions. Thus, the typical objectives of the research can be summarized as follows:

- To review and synthesize existing knowledge
- To investigate some existing situation or problem
- To provide solutions to a problem
- To explore and analyze more general issues
- To construct or create a new procedure or system
- To explain a new phenomenon
- To generate new knowledge
- A combination of any of the above

The above summary illustrates that research is purposeful, as it is conducted with a view to achieving an outcome. The nature of that outcome will depend on the type of research you are conducting and the level at which you are operating. Though each research study has its own specific purpose, research in whatever field of inquiry has four general purposes, i.e. describing, explaining and predicting phenomena and ultimately controlling events.

Describing and explaining: This is the attempt to understand the world we live in. Research is concerned with acquiring knowledge, establishing facts and developing new methods. The way this understanding is shown is through the theories developed and their efficacy at explaining the world in which we live.

Prediction: In research, predictions are usually stated as hypotheses, i.e. clear unambiguous statements which can be subjected to scientific verification or refutation. When the hypotheses are accepted or rejected, we are able to make generalizations or theories concerning various situations. We are able to say that given these conditions then this is likely to happen.

Control: This follows from our knowledge and the successful verification of hypotheses. Control represents the way in which research can be applied to real problems and situations, thus helping us to shape our environment. When we understand the relationship between variables we are able to control our environment to suit our interests.

2.6. Motivation in Research

The motivating force in every research is the existence of a problem, and the interest to solve that problem. In doing particular research, a researcher may be motivated by one or more of the following among other reasons:

- To fulfill an academic requirement for example as partial fulfillment for the award of a masters/doctorate degree.
- In an effort to solve practical problems of the society; For enjoyment; some people enjoy the intellectual challenge of creative work
- Delegation by some authority; a researcher may be called upon to study a specified phenomenon by some higher authority.
- To generate new theories, confirm existing ones or disapprove them.
- To be informed; to contribute to the existing body of knowledge. This is mainly triggered by a curiosity about a subject.

However, this is not an exhaustive list of factors motivating people to undertake research studies. Many more factors such as directives of the government, employment conditions, curiosity about new things, desire to understand causal relationships, social thinking and awakening, and the like may as well motivate (or at times compel) people to perform research operations.

2.7. The Characteristics of Research

Research is a process of collecting, analyzing and interpreting information to answer questions. But to qualify as research, the process must have certain characteristics: it must, as far as possible, be controlled, rigorous, systematic, valid and verifiable, empirical and critical.

Controlled: In real life, there are many factors that affect an outcome. The concept of control implies that, in exploring causality in relation to two variables (factors), you set up your study in a way that minimizes the effects of other factors affecting the relationship. This can be achieved to a large extent in the physical sciences (cookery, bakery), as most of the research is done in a laboratory. However, in the social sciences (Hospitality and Tourism) it is extremely difficult as research is carried out on issues related to human beings living in society, where such controls are not possible. Therefore in Hospitality and Tourism, as you cannot control external factors, you attempt to quantify their impact.

Rigorous: you must be scrupulous in ensuring that the procedures followed to find answers to questions are relevant, appropriate and justified. Again, the degree of rigor varies markedly between the physical and social sciences and within the social sciences.

Systematic: this implies that the procedure adopted to undertake an investigation follow a certain logical sequence. The different steps cannot be taken in a haphazard way. Some procedures must follow others.

Valid and verifiable: this concept implies that whatever you conclude on the basis of your findings is correct and can be verified by you and others.

Empirical: this means that any conclusions drawn are based upon hard evidence gathered from information collected from real-life experiences or observations.

Critical: critical scrutiny of the procedures used and the methods employed is crucial to a research inquiry. The process of investigation must be foolproof and free from drawbacks. The process adopted and the procedures used must be able to withstand critical scrutiny. For a process to be called research, it is imperative that it has the above characteristics. In general scientific research is characterized by the following convictions:

- It involves gathering new data or using existing data for a new purpose. It is not merely reproducing information such as would be produced by a student when asked to 'research' on a topic and write a paper.
- It is directed towards the solution of a problem. The 'problem' is the focus of the whole research process in that the entire design aims at how the problem can be solved or how the research question(s) can be answered.
- It relies on empirical evidence, i.e. on events or data that can be verified by observation. This distinguishes formal research from informal research whose findings and conclusions are based on popular belief, dogma, hearsay, hunches, guesswork and other subjective methods that people resort to when seeking answers to questions.
- It is systematic in procedures of planning, collection of data, analysis, and reporting. It follows clearly stipulated procedures. All these must be carefully recorded and described. Research ethics require that terms are defined, limiting factors stated, procedures described, references given and results reported faithfully. The report should also be availed for scrutiny by other interested researchers.
- It aims at generalizing findings to larger groups by discovering general principles that will be helpful in predicting future occurrences. This calls for careful sampling procedures to ensure that the sample is representative of the larger group.
- It requires careful and accurate observation and description.

- It is logical and objective; every possible step is taken to ensure the validity of procedure, tools, and conclusions. The researcher strives to eliminate personal feelings and bias. These could be intended or unintended. The emphasis is on testing rather than proving the hypothesis.
- Research findings are sometimes contrary to popular belief. That it is notwithstanding, the researcher should always report findings as they are. Courage is then required to report faithfully.

2.8. Classifying Research

As there are many ways of classifying research, it can be bewildering at first. However, studying the various characteristics of the different types of research helps us to identify and examine the similarities and differences. Thus, we can base our classification on the outcome of the research – whether the expected outcome is the solution to a particular problem or a more general contribution to knowledge, the process of the research – the way in which the data were collected and analyzed or the purpose of the research – the reason why it was conducted.

The attempt to classify research into these categories is somewhat misleading since most research has elements of all the categories. It should be said that it is only an aid to a broad understanding of the different types of research rather than distinct categories.

2.8.1. Types of Research

Applied and Basic Research

A standard classification of research divides projects into applied research and basic research. Applied research is a study that has been designed to apply its findings to solving a specific, existing problem. It is the application of existing knowledge to discover a solution for some pressing practical problem. The research project is likely to be short term (often less than 6 months) and the immediacy

of the problem will be more important than academic theorizing. For example, the improvement of safety in the workplace or the reduction of wastage of raw materials/ energy in a factory process/. The output from this type of research is likely to be a consultant's report, articles in professional or trade magazines and presentations to practitioners.

Applied research is increasingly gaining favor as it helps to address the problems facing the world today such as overpopulation, pollution, depletion of natural resources, drought, floods, declining moral standards, and disease.

Action research is a unique form of applied research. It is a reflective process of progressive problem-solving. It is also called "practitioner research" because of the involvement of the actual practitioner in real life. Action implies that the practitioner is involved in the collection of data, analysis, and the interpretation of results. He or she is also involved in implementing the results of the research and is thus well placed to judge the effectiveness of the interventions. When the research problem is of a less specific nature and the research is being conducted primarily to improve our understanding of general issues without emphasis on its immediate application, it is classified as basic or pure research. Basic research is regarded as the most academic form of research, as the principal aim is to make a contribution to knowledge, usually for the general good, rather than to solve a specific problem for one organization.

Basic research may focus on problem-solving, but the problem is likely to be theoretical rather than practical. The typical outcome of this type of research is knowledge. Basic research may not resolve an immediate problem but will contribute to our knowledge in a way that may assist in the solution of future problems. The emphasis, therefore, is on academic rigor and the strength of the research design. The output from basic research is likely to be papers presented at academic conferences and the articles published in academic journals. For example, Research concerning some

natural phenomenon or relating to pure mathematics are examples of fundamental research. Thus the central aim of basic research is directed towards finding information that has a broad base of applications and thus, adds to the already existing organized body of scientific knowledge.

Qualitative and Quantitative Research

Qualitative research deals with designs techniques and measure that do not produce discrete numerical data. It involves extensive narrative data in order to gains insights into phenomena. Data analysis includes the coding of the data and the production of verbal synthesis (inductive process). Examples include historical research, ethnographic research, participant observational research and the case study. Quantitative research includes designs, techniques, and measures that produce discrete numerical or quantifiable data. Data analysis is mainly statistical (deductive process).

Some researcher prefers to take a quantitative approach to address their research question(s) and design a study that involves collecting quantitative data (and/or qualitative data that can be quantified) and analyzing them using statistical methods. Others prefer to take a qualitative approach to address their research question(s) and design a study that involves collecting qualitative data and analyzing those using interpretative methods.

Always a large study might incorporate elements of both as their merits are often considered to be complementary in gaining an understanding in the social sciences. Referring to a research approach as quantitative or qualitative can be misleading, as a researcher can design a study with a view to collecting qualitative data (for example published text or transcripts of interviews) and then quantifying them by counting the frequency of occurrence of particular keywords or themes. This allows researchers to analyze their data using statistical methods. On the other hand, a researcher can collect qualitative data with the intention of analyzing those using non-numerical methods or collect data that are already in numerical form and use statistical methods to analyze them.

The choice between quantitative and qualitative approach will be influenced by the nature of the research project as well as researchers own philosophical preferences. Moreover, you may find that the access you have been able to negotiate, the type of data available and the research problem persuade you to put your philosophical preferences to one side.

Experimental and Non-Experimental Research

If we are classifying research according to its purpose, we can describe it as being exploratory, descriptive, analytical or predictive.

Experimental research is one where the study subjects are studied as they are in the natural environment without any manipulation or active effort to control them. Exploratory and descriptive studies come under non-experimental research. Exploratory and descriptive researches seek to explore or identify the kinds of factors responsible for the variables under investigation. The final result is a list of factors as revealed by the respondents in the research.

Exploratory research is conducted into a research problem or issue when there are very few or no earlier studies to which we can refer for information about the issue or problem. The aim of this type of study is to look for patterns, ideas or hypotheses, rather than testing or confirming a hypothesis. A hypothesis is a proposition that can be tested for association or causality against empirical evidence. Empirical evidence is data based on observation or experience, and data are known facts or things used as a basis for inference or reckoning. In exploratory research, the focus is on gaining insights and familiarity with the subject area for more rigorous investigation at a later stage.

Typical techniques used in exploratory research include case studies, observation, and historical analysis, which can provide both quantitative and qualitative data. Such techniques are very flexible as there are few constraints on the nature of activities employed or on the type of data collected. The research will assess which existing

theories and concepts can be applied to the problem or whether new ones should be developed. The approach to the research is usually very open and concentrates on gathering a wide range of data and impressions. As such, exploratory research rarely provides conclusive answers to problems or issues, but gives guidance on what future research, if any, should be conducted.

Descriptive research is conducted to describe phenomena as they exist. It is used to identify and obtain information on the characteristics of a particular problem or issue. Descriptive research goes further in examining a problem than exploratory research, as it is undertaken to ascertain and describe the characteristics of the pertinent issues.

Non-Experimental research is research that requires manipulation of some of the variables after the research subjects have been divided into treatment groups. Explanatory or analytical studies come under this group and are able to provide a cause-effect relationship between variables under study. Analytical or explanatory research is a continuation of descriptive research. The researcher goes beyond merely describing the characteristics, to analyzing and explaining why or how the phenomenon being studied is happening. Thus, analytical research aims to understand phenomena by discovering and measuring causal relations among them. An important element of explanatory research is identifying and, possibly, controlling the variables in the research activities, as this permits the critical variables or the causal links between the characteristics to be better explained. A variable is a characteristic of a phenomenon that can be observed or measured.

Predictive research goes even further than explanatory research. The latter establishes an explanation for what is happening in a particular situation, whereas the former forecasts the likelihood of a similar situation occurring elsewhere. Predictive research aims to generalize from the analysis by predicting certain phenomena on the basis of hypothesized, general relationships. Thus, the solution to a problem

in a particular study will be applicable to similar problems elsewhere, if the predictive research can provide a valid, robust solution based on a clear understanding of the relevant causes. Predictive research provides 'how', 'why' and 'where' answers to current events and also to similar events in the future. It is also helpful in situations where 'what if' questions are being asked.

Activity 2.3

a) List the types of research.

b) Differentiate between applied research and basic research.

2.9. Overview of the Research Process

Before embarking on the details of research, it seems appropriate to present a brief overview of the research process. Whatever type of research or approach is adopted, there are several fundamental stages in the research process that are common to all scientifically based investigations. The research process consists of a series of actions or steps necessary to effectively carry out research. Systematic, well-designed research provides an effective approach to the solution of all scientifically based investigations. Hence, to investigate research questions and hypotheses systematically, the following order concerning various steps provides a useful procedural guideline regarding the research process. The steps may include the following:

- Choose a topic, search the literature and define the research problem
- Review the literature
- Write the proposal
- Collect the research data
- Analyze and interpret the research data
- Write the research report
- Disseminate results

This step presents research as a neat, orderly process, with one stage leading logically to the next stage. However, in practice, research is rarely like that. For example, failure at one stage means returning to an earlier stage and many stages overlap. Thus, if you were unable to collect the research data, it may be necessary to revise your definition of the research problem or amend the way you conduct the research. This is often a good reason for conducting some exploratory research before commencing a full project. We will look briefly at each stage of the research process in the subsequent units.

2.10. Unit Summary

- Research is a planned and systematic application of the scientific method to the study of problems.
- The purposes of research in all fields are describing, explaining and predicting phenomena and controlling events.
- Scientific research is conducted using the scientific method.
- The scientific method is a series of steps that scientists use to answer questions and solve problems.
- The characteristics of the scientific method are public, objective, empirical, systematic and cumulative and predictive.
- Basic or pure research is research that provides baseline information.
- Applied research findings could have immediate practical utility because they could be used to solve problems, make decisions or develop new products.
- Experimental research involves manipulation of variables while non-experimental research is conducted in the natural environment without any manipulation of variables.

- Research must, as far as possible, be controlled, rigorous, systematic, valid and verifiable, empirical and critical.

- The research process consists of different steps that are common to all scientifically based investigation.

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2.12. Unit Exercise

1. Which of the following statements would be true of the scientific method?

   a) The scientific method is a linear process starting with observation and following several other rigidly defined steps.

   b) The scientific method is a continuous process by which people learn about the physical universe and share their knowledge with others.

   c) Scientists may report findings in such a way that experiments and observations remain known only to the original experimenters.

   d) When the results of an experiment do not fit the hypothesis, a scientist may ethically discard the results and repeat the experiment.

   e) The scientific method has no connection to the way people conduct their lives every day.

2. The first step of the scientific method involves:

   a) Forming a hypothesis

   b) Making observation

   c) Performing an experiment

   d) Predicting the result of an experiment

   e) All of the above.

3. A pattern or relationship that has been established based on a large amount of experimental data is

   a) Theory
   b) Hypothesis
   c) Law
   d) A and B only.
   c) All of the above.

What is research?

a) An activity caused by instinct inquisitiveness to gain fresh insight/find answers to questions/acquiring knowledge.

b) It is the systematic process of collecting and analyzing information to increase our understanding of the phenomenon under study.

c) It is the function of the researcher to contribute to the understanding of the phenomenon and to communicate that understanding to others.

d) A and B only.

e) All of the above.

5. The classification of studies into applied or basic research is based on:

a) The process of the research

b) The outcome of the research

c) The purpose of the research

d) The logic of the research

e) A and C only.

6. Basic research scientists

a) Are interested in finding out how the world works for the sake of acquiring fundamental knowledge.

b) Believe in the healing power of meditation.

c) Want their research to have practical application to industry or technology.

d) Are also known as theorists.

e) Would be likely to have a patent on a discovery.

7. When scientists have finished research and wish to communicate the results, they are most likely to do which of the following?

a) Immediately repeat the research.

b) Call a press conference.

c) Sell their findings to a research and development company.

d) Write a concise paper and submit it to a scientific journal.

e) Submit an abstract to a popular science magazine.

8. Which of the following statements would be true of the scientific method?

a) The scientific method is a linear process starting with observation and following several other rigidly defined steps.

b) The scientific method is a continuous process by which people learn about the physical universe and share their knowledge with others.

c) Scientists may report findings in such a way that experiments and observations remain known only to the original experimenters.

d) When the results of an experiment do not fit the hypothesis, a scientist may ethically discard the results and repeat the experiment.

e) The scientific method has no connection to the way people conduct their lives every day.

9. A pattern or relationship that has been established based on a large amount of experimental data is:

a) Theory

b) Hypothesis

c) Law

d) A and B only.

e) All of the above.

10. Basic research scientists:

a) Are interested in finding out how the world works for the sake of acquiring fundamental knowledge.

b) Believe in the healing power of meditation.

c) Want their research to have practical application to industry or technology.

d) Are also known as theorists.

e) Would be likely to have a patent on a discovery.

UNIT THREE

RESEARCH METHODS

3.1. The Process of Conducting Research

As discussed earlier in unit two, a research process consists of a number of closely related activities that overlap continuously rather than following a strictly prescribed sequence. In a large measure, the development of a research process is a cyclical one. It is not a one-line process. The general pattern, however, consists of:

- Choose a topic, define the research problem and search the literature
- Review the literature
- Write the proposal
- Conduct research and collect the research data
- Analyze and interpret the research data
- Write the research report
- Disseminate results

In this unit, a brief discussion of each stage of the research process will be presented.

3.2. Unit Objectives

At the end of this unit, you should be able to:

- List the criteria for selecting a research topic
- Describe the purposes of the literature review
- Take notes from different literature
- Define a research proposal

- Describe the purpose of writing a research proposal
- Outline the common sections of a proposal
- Describe the concern in each section of a research proposal
- Differentiate between general and specific objectives
- Define a work plan and what a work plan may include
- Outline points to keep in mind when preparing a work plan
- Outline the importance of budget preparation
- Select and develop appropriate major categories for a budget
- Describe the importance of referencing in a research proposal
- Define data collection, and give an overview of the process
- Identify and describe three methods of data collection
- Define data analysis and mention data analysis methods.

3.3. Choosing a Topic, Defining the Research Problem and Searching the Literature

The starting point is to choose a research topic, which is a general subject area that is related to your degree if you are a student or your discipline if you are an academic. Selecting a research topic is not always easy for many beginning researchers, especially those writing term papers, theses, and dissertations. The problem relies on where to start. Fortunately, there are virtually unlimited sources available in searching for a research topic; you may find a research topic suggests itself as a result of your coursework, job, interests or general experience. In addition, you can also identify a research problem (research topic) by reading scientific literature and identifying any gaps, as these indicate original areas to research. You will also find that many academic articles may provide ideas for research topics. Most authors conclude their research by discussing the problems encountered during the study and suggesting topics that need further investigation. In addition, some journal editors build issues around individual research themes, which often can help in formulating research topic.

3.3.1. Sources of Research Problem

There are many problem situations that may give rise to research. Three sources usually contribute to problem identification:

- One's own experience or the experience of others may be a source of problem supply.
- A second source could be scientific literature. You may read about certain findings and notice that a certain field was not covered. This could lead to a research problem.
- Theories could be a third source. Shortcomings in theories could be researched.

The research, therefore, originates from a need that arises and it can be aimed at clarifying or substantiating an existing theory or at solving existing practical problems.

3.3.2. Searching Literature

Once you have chosen a general topic, you need to search the literature for previous studies and other relevant information on that subject and read it. The best place to begin searching for relevant information about your research topic is the library. The library will have magazines, newspapers, and books on the subject, scientific references, and electronic resources, each with information about some aspect of your topic. You could start with textbooks in the area or chapters of textbooks. Textbooks explain the basic concepts and facts related to the issue and may cite research in the area which will be listed in the 'references' which you could further explore. Journals publishing review articles provide valuable information about a particular field as they review related literature. Next is to read articles in the relevant journals in the field. You should look through the catalog both in the library and on-line and identify the journals in your field. Journals report empirical evidence about the field you are interested in and they indicate the current thinking about research and the trend of research efforts in the field. Thus, by exploring the existing body of knowledge, you should be able to see

how your topic is divided into a number of different areas that will help you focus your ideas on a particular research problem.

3.3.3. The Research Problem

All students experience some difficulty in narrowing down their general interest in a research topic to focus on a particular research problem or issue that is small enough to be investigated. This is often referred to as defining the research problem and leads on to setting the research question(s) or find a narrower perspective or focus on the topic by asking a series of questions about the topic.

It is very important that you choose a topic that interests you and for which there are enough sources available. List a number of general topics. Each topic contains numerous potential research problems to guide different research studies. Thus, from your list, select several topics and develop more specific subjects. Choose the best subject for the paper. It is important, also, that the topic should not cover too broad an idea. Instead, the topic should be limited in scope.

Once you have selected and researched your topic, generate a question which explains the point of your subject and what you will cover. If, on the other hand, you find volumes of information, then you need a plan to scale your search down to a manageable amount. Specific aspects of a field of study are often listed in annotated bibliographies. Journals specific to a field are good sources. It is then necessary to assess how the topic can be narrowed down to potential sub-topics for more thorough consideration. The following checklist contains one set of general questions and five sets of specific questions for specific types of topics. It is recommended that you read all the questions in all sub-sections because the questions may trigger ideas that you have not considered previously.

- Is there current interest in this topic in your field or in a closely related field?
- Is there a gap in knowledge that work on this topic could help to fill or a controversy that it might help to resolve?

- Is it possible to focus on a small enough segment of the topic to make a manageable thesis project?
- Can you envisage a way to study the topic that will allow conclusions to be drawn with substantial objectivity? Is the data collection approach (i.e. test, questionnaire, and interview) acceptable in your school?
- Is there a body of literature available relevant to the topic? Is a search manageable?
- Are there large problems (i.e. logistic, attitudinal) to be surmounted in working on this topic? Do you have the means to handle them?
- Does the topic relate reasonably well to others done in your department? If not, do you have any information about its acceptability?
- Would financial assistance be required? If yes, is it available?
- Are the needed data easily accessible? Will you have control of the data?
- Do you have a clear statement of the purpose, scope, objectives, procedures, and limitations of the study? Do you have a tentative table of contents? Are any of the skills called on by the study skills that you have yet to acquire?

3.4. Literature Review

An introduction chapter in a research paper generally includes information gleaned from a thorough literature search. A literature review is essential and an integral part of the process of conducting research and it requires careful and perceptive reading and attention to detail. The literature review is usually presented in a specific section of the research document, but sometimes forms part of an introductory section or chapter. The review should discuss material relevant to the aims of the research. It gives your reader background information regarding your own research, demonstrates your familiarity with research in your field, and shows how your work contributes one more piece in the puzzle of expanding the knowledge

base in your field. The important idea to convey is that you really understand what others in your field have accomplished and how your work differs from the works of others. In a literature review, you demonstrate your understanding of the relevant works of others and your ability to summarize this information for the convenience of your readers. This sets the stage for you to describe what your research contribution is going to be or how your own work has added to knowledge on the subject. Moreover, the researcher, by conducting a thorough literature review may avoid unnecessary duplication of research which has already been published. Much time and effort can be saved by reviewing the chemical literature before the experimental work is started. In general, reviewing literature is used for either

- Gathering information to learn about a specific subject or topic.
- Specifically limiting and identifying the research problem and possible hypothesis or research questions i.e. sharpening the focus of the research.
- Informing the researcher of what has already been done in the area. This helps to avoid exact duplication.
- It increases your knowledge on the problem you want to study and this may assist you in refining your "statement of the problem".
- It gives you confidence why your particular research project is needed.
- To be familiar with different research methods
- Gathering data and information for the laboratory (experimental protocols, physical data on compounds, etc.)

As a beginner researcher, two of the most common problems you might encounter during literature review process are i) not knowing where to find sources, and ii) once sources are located, not knowing how to sift or sort through an excess of information to determine

what is useful to you. In order to overcome these difficulties during your literature review process, you need to know what information you will need, and you need to know where to get your hands on it.

Activity 3.1

a. List the possible source of a research problem (or topic).

b. What is meant by defining a research problem?

3.4.1. Sources of Literature Review

These include primary and secondary sources. A primary source is the description of research written by the original researcher. Journals are the best primary source for literature. They are also the most current and available in print and electronic forms. A secondary source is a description of a study prepared by someone other than the original researcher. Secondary sources are often interpretations of the original work, and so may not serve all the needs of another researcher. For example, a research article cited by another person in a journal is a secondary source, but that author's own report in the same journal is a primary source. These literature materials could be held in libraries as hard copies, abstracts, indexes, or available as Internet-based literature.

Libraries are one obvious resource for a student performing a literature search, but there are many others as well, including the internet. The internet is a valuable tool for students doing research. Regardless of the sources you use, keep a bibliographic trail. That is, track titles, authors, publication information, page numbers, and possibly library call numbers (LCN), etc. These tracking habits can help you avoid duplication of effort and speed the process of obtaining permission (to use the work of others) when needed. The time required to relocate and reacquire a source is also reduced. You will also be constructing your reference chapter as you work. Retracing these efforts by memory is very risky, so it is better if you take notes at every step.

3.4.2. Conducting a Literature Review

As a beginning researcher, you need to plan for the review, by your statement of the problem, selection of keywords or phrases that would facilitate a search for material, and evaluating the materials. It will be better for you to start from the recently published materials. Check with the reference librarian, check textbooks for leads, and also abstracts (in print and online databases), and journals. Journal article references could lead you to more related reference material that meets your literature requirement. Recording of exact references is encouraged on cards, in a notebook, or on a computer database. It is important to record the name of the author(s), and year of publication, for books – title, edition, chapter, and the publisher. For journals, the title of the article, name of the journal, the volume, issue/number, and the page numbers are important. These enable you to have these at hand when you are writing up your literature review. The following questions may serve as a guide for literature review:

- Who is (are) the author(s)?
- What was the reason for the study or article?
- Is there evidence of wide reading by the author(s)?
- How was the information (data) gathered and analyzed?
- Were the research questions answered/ and were the hypotheses tested?
- What did the research conclude?
- Were there useful recommendations?

Applying these questions to each of the studies reviewed will enable the researcher to have all necessary information from the reviewed materials, and limit the need to go back to check or update on their notes.

3.4.3. Writing/Summarizing Literature Review

Once information is located, the next step is to summarize it into a coherent literature review section for your document. You must analyze accurately and critically. It takes a lot of skimming of books and articles to identify which sources are useful to you and in what context they are useful. Your goal at this point is to present an overview of what your source offers; it is topic, research problem, resolution, and the outlines of its argument. The abstract, introduction and conclusion sections of each source document should contain the necessary information for you to write a good summary paragraph. It can be very counterproductive to try to read everything in detail and try to condense others' work without distorting it. There are three ways to use sources in research writing: quoting, paraphrasing, and summarizing.

Quotations: This is an exact copy of the original material. It is set off with quotation marks " ", or set off in a block from the main text. You use quotations in your writing when you need to invoke the authority of your source, to preserve the qualities of the written language, or when the original material is so well phrased that a summary or paraphrase just won't capture the ideas. In writing, you must avoid naked quotes. In other words, be sure to introduce a quote with a sentence or part of a sentence of your own that makes reference to the quote or names the source, and nicely incorporates the quote into your own writing. Naked quotes are just padding and add little to the meaning of the paper. A quotation must be documented.

Paraphrase: Paraphrasing is restating in your own words the materials you have read. It reproduces the thought and meaning of the original, but not the wording or sentence structure. A paraphrase usually results in writing of equivalent textual length as the original, but, of course, with different words and, ideally, different sentence structure. When an author takes a portion of text from another source, thoroughly paraphrases it, he/she must give credit to its author. A good paraphrase shows that you have understood and assimilated

the material enough to use it in your paper. By paraphrasing lengthy source material to incorporate into your paper, you maintain consistency of style throughout your paper. A paraphrase must be documented.

Summarizing: In summarizing material, you present a much shorter version of a longer prose section from your source. A summary contains the significant points of the material, often drawn from the topic sentences of the paragraphs. It reproduces the main idea of the original, but not the wording or sentence structure. It is much shorter than the original, perhaps condensing many pages to a few sentences. Use summaries where you need only the essential information from your source. As with paraphrasing, summaries demonstrate that you have mastered the material enough to include it. Also, summaries, like paraphrases, are more readily integrated into your own style of writing. A summary must be documented. While taking notes and preparing condensed summaries of the work of others, you must be ever mindful of the requirement to eventually cite all borrowed work in your final paper. In each case, you need to cite your source.

Activity 3.2

a. List the advantage of literature review.

b. Describe the ways of using literature sources during literature review writing.

3.5. Writing a Research Proposal

Formulation of the research proposal is the major task in the research process. The proposal draws on all the preparatory steps of the research process and pulls them together in a document describing the rationale and the methodology proposed for research. it is considered as a plan of action that contains all the key elements involved in the research process and it also includes sufficient information for the readers to evaluate the proposed study. Research proposal or protocol is a concise written plan of the research you intend to undertake or it is the written plan for the research project

or it is a detailed description of a series of activities aimed at solving a certain problem. In general, it is just that – it is what you propose to do. The proposal needs to show clearly that you understand your field, you have identified an area that warrants research and you know how to conduct that research. The reason why it is necessary to write research is that it serves as a guideline in structuring one's research in such a manner that the study one is planning will be worthwhile.

In writing proposals, the key decision to be made is the structure of the project proposal (including the proposal format, steps, and sequencing of the steps). The structure is determined by the nature of the project as well as by the funding agency's (institutional) requirements. Thus, project/research proposals are likely to align themselves to these specific institutional preoccupations. For example, academic and research institutions will, for example, focus on the need for comprehensive literature review that will demonstrate that the researcher is committed to new knowledge having exhaustively made him/herself aware of previous works on the subject.

3.5.1. Objectives of Research Proposals

Analysts on proposal writing have identified various purposes or functions which a research proposal seeks to realize. These functions at least include the following:

- To convince others that one has a worthwhile research project and that one has the competence and work-plan to complete it. Generally, a research proposal should contain all the key elements involved in the research process and include sufficient information for the readers to evaluate the proposed study.
- A research proposal is as a planning tool. A research or project proposal is, is a map or sketch of activities to be executed, resources to be employed, a time frame to be adhered to, etc. In this case, a project/research proposal is an indication of an execution plan. For any undertaking worthy its recognition, there has to be a plan for it.

- A research proposal serves the function of convincing other people, like other researchers, research funding agencies, educational institutions, and supervisors that the research is worth spending scarce resources on. One convinces people of the value of one's work by showing them how the research will make a difference to the world or by identifying a dilemma in existing theory which the research will help resolve.

- A research proposal demonstrates the expertise of the researcher in a particular area of study. One wants, in a research undertaking to convince people that one has enough understanding of the research topic to be able to do the research properly. This, one wants to do by intelligently summarizing, comparing and integrating all the relevant theory and existing research pertaining to one's topic.

- A research proposal seeks to demonstrate competency in a particular area of study. It is also vital that one's proposal convinces the reader that one has all the necessary skills to carry out the proposed study. This one does by describing an appropriate and feasible research method.

- Research often involves contracts between different individuals or groups of people. The proposal states clearly what each party is expected to bring to the research, how resources will be used, and when the research should be completed.

In general, a research proposal is a document that presents a plan for a project to reviewers for evaluation. It can be a supervised project submitted to instructors as part of the educational degree (e.g., bachelor's term paper, master's thesis or Ph.D. dissertation) or it can present a project proposed to a funding agency. Its purpose is to convince reviewers that you, the researcher, are capable of successfully conducting the proposed research project.

Reviewers have more confidence that a planned project will be successfully completed if the proposal is well written and organized, and if you demonstrate careful planning.

3.5.2. Components of the Research Proposal

Research Proposals come in different formats. Often they are tailored towards the needs of different institutions/ clients/ donor/ funding agency. Every donor/funding agency has its own preferred format or proposal outline. Thus, research proposal formats and their emphatic areas are shaped by institutional needs. But even within one institutional type, there can be competing ways of addressing the same elements. However, despite the several formats, some sections are common in all proposals. The generic (conventional) proposal format has the following sections not necessarily the same order. It should be noted that the proposal will be designed after a topic is accepted to be researched. And, for approval, the proposal (protocol) design is required to include at least the contents given below:

- Title and cover page
- Literature review (Background)
- Objectives
- Material and methods
- Work plan
- Budget
- References

Title and Cover page

The cover page (see example below) gives essential information about the proposal. It should contain the title, the name of the researcher(s) with their titles and positions, the institution, department, the project mentors or supervisors/ advisors and the month and year of submission of the proposal. The title of the research proposal is

usually the first and most-read part of a proposal and therefore it should be brief and accurate, but at the same time descriptive and comprehensive. That is, it should convey maximum information in fewer words (not more than 12-15 words) than any other part of the protocol. In other words, it should introduce the research question; specify the research method to be used and indicating the area where the study will be undertaken. Sample cover page of a typical M.Sc. The project proposal is shown in Appendix I.

Literature review ((Background)

In this section, you should present the work published in the literature related to your research topic. The aim is to give a short and precise overview of previous research that has been conducted related to your research problem (Olivier, 2009). Identify some of the most important contributions of previous research work. The proposal should also include a discussion of the theoretical framework or ideas that will be used to frame the research work. The proposal needs to show that you are acquainted with the topic you are dealing with and that you are able to relate your research topic to the existing knowledge in the field.

Your literature review should provide motivation for the proposed research project. It should also include how your own research will advance or provide a new perspective to the existing research. An investigation of the background information has to be more than surface-based as it helps the researcher to identify the gaps in existing knowledge on the subject of research, and in the process, helps the researcher to modify his/her research focus accordingly. The researcher may begin to document the most recent local and internationally relevant research as background and motivation for the project. Only relevant research should be documented by integrating the research reported by others in the specific field. Be clear to substantiate statements, provide proof and use the information to develop appropriate methods and meaningful hypotheses. In most academic proposals, one needs to address the problem by summarizing at least the following points:

- What is already known about the research problem? (Studies that have addressed the problem)
- What are the gaps in the present body of knowledge? (Deficiencies in the studies)
- Where and how does the proposed research fit into this picture? (The purpose statement)
- What contribution will the proposed research make to the existing academic knowledge base and how will it enrich current practices? (The importance of the study for the audience)

A literature review which falls short of these concerns only solidifies the evaluator's suspicion that the researcher did not carry out satisfactory background investigation on the chosen research problem and therefore lacks a conclusive understanding of the key issues around it.

Objectives

Research Objectives are a reworking of the statement of the research problem. It is the essence of the inquiry. It is a relationship statement in a declarative format. The objective of certain research summarizes what to be achieved by the study. It should clearly define the question for which a solution is being sought.

The proposal's writer should consider the following points on stating his/her research objectives so as:

- To be clearly related to the statement of the problem
- To cover the different aspects of the problem
- To be clearly phrased in operational terms specifying exactly what you are going to do, where and for what purpose

- To be realistic considering local conditions and available resources
- To use specific action verbs such as" to determine, to identify, to verify, to describe, to calculate"
- To avoid vague non-action verbs such as 'to study', 'to appreciate', 'to understand"

Research objectives should be ranked in a hierarchical form. This is because there are at least two levels of objectives. The research objectives are classified into two higher or broad (general) objectives and the lower or specific objective. As it says, the first category of objectives refers to a broad developmental goal within which the research proposal falls. The second level comprises of specific objectives and they are derivatives of the general objectives.

General objectives

The general objectives provide a short statement of the development goal being pursued by the research. These will define what is expected to be achieved by the study in general terms.

Specific objectives

Specific objectives are operational in nature. These may indicate specific types of knowledge to be produced, certain audiences to be reached, and certain forms of capacity to be reinforced. The specific objectives can be several. These are the objectives against which the success of the project will be judged. These are the objectives that address the various aspects of the problem and the key factors that are assumed to cause or influence the problem. The specific objectives of research work should be SMART (specific measurable achievable reliable and time-bound) and focus on the following points:

- To identify the distribution and patterns of a problem

- To examine the possible factors that may influence the problem

- To indicate how the research results will be used.

In addition to objectives, a hypothesis can be formulated in some studies (Beaglehole *et al.* 1993). A hypothesis is a suggested or assumed explanation for the research problem that can be tested. It is a prediction for a relationship between one or more factor and the problem under study. In general, the objectives should meet the purpose of the study. They should be phrased clearly, unambiguously and very specifically. Also, they should be phrased in measurable terms.

Materials and methods

It is the most detailed part of the proposal and describes the process you will undertake to complete the research. The researcher must describe, in painful detail, exactly what he/she will do: What experiments are running and how they are run, what equipment and materials are used and how they are used. It should also include the type of the study, criteria of selection of samples, calculation of the sample size (number of the samples should be key to the minimum necessary for valid results), chemicals and reagents, methods of data collection, measurement and analysis. In general, some of the information the section must include is:

- Samples used and their pre-experiment handling and care (anything that might affect the results must be included)

- Sample preparation techniques

- Origins of samples and materials

- Description of the field site (if applicable) including physical and biological features, and exact location (include a map, if applicable)

- Protocol for collecting data - how were the procedure carried out?
- Statistical analysis techniques used. If used (for example, in ANOVA tests), the author must report the threshold used to determine statistical significance.
- Information on computer programs used or written (for some computer science or physics articles, the author should include the relevant codes in the appendix)
- Descriptions of equipment set-up and function

If parts of the experiment have been described elsewhere, then the researcher may reference it. For example: "Samples will be prepared using the same process as described by Newton et al. (2000)." Otherwise, the author must describe each piece of the experiment.

Work plan

A work plan is a schedule, chart or graph that summarizes the different components of a research project and how they will be implemented in a coherent way within a specific time span. It may include:

- The tasks to be performed
- When and where the tasks will be performed and
- Who will perform the tasks and the time each person will spend on them.

Ways of presenting a work plan

A work plan could be presented in the form of a work schedule, Gantt chart, etc.

The work schedule

A work schedule is a table that summarizes the tasks to be performed in the research project, the duration of each activity, and the staff

responsible. The version of the work schedule given on the following pages includes:

- The tasks to be performed;
- The dates each task should begin and end
- Research team, research assistants, and support staff (drivers and typists) assigned to the tasks; and
- Person-days required by the research team members, research assistants, and support staff (the number of person-days equals the number of working days per person).

The work schedule shows the tasks to be completed, how long they take, and who is to be assigned to each one, but does not show how various tasks are related to each other and it does not give a visual picture of the time schedule. In most cases, you can use a table for the work schedule as in the example shown in Appendix II.

The Gantt chart

The Gantt chart is a planning tool which depicts graphically the order in which various tasks must be completed and their duration of an activity. The length of each task is shown by a bar that extends over the number of days, weeks or months the task is expected to take. A typical Gantt chart includes the following information:

- The tasks to be performed
- Who is responsible for each task; and
- The time each task is expected to take.

The Gantt chart shows the tasks to be completed and illustrates visually how long they will take, but doesn't show how various tasks are related. It may show who will be involved in completing the tasks. You can use a Gantt chart as in the example shown in Appendix III.

A work plan can serve as:

- A tool for planning the details of the project activities and drafting a budget
- A visual outline or illustration of the sequence of project operations. It can facilitate presentations and negotiations concerning the project with government authorities and other funding agencies
- A management tool for the team leader and members of the research team, showing what tasks and activities are planned, their timing, and when various staff members will be involved in various tasks
- A tool for monitoring and evaluation, when the current status of the project is compared to what had been foreseen in the work plan

Budget Plan

A budget is a financial plan expressed in a financial statement. The plan must be on items that need expenditure on. The budget of research work is essentially a document of its expenses. The researcher is required to outline the capital and running costs together with the hidden costs such as the use of already existing laboratories, libraries and computer facilities, technical and secretarial help, duplication, language editing, statistical services, hiring of equipment in addition to the costs of travel of researchers and subjects. In a general sense, one can derive generic features and formats of a budget. Such a budget structure could comprise the following items as they are indicated in Table 3 just below. What is important is that a research proposal will require a budget proposal attached to it. The budget, as complete and as detailed as possible, should be in clear tabular form.

Why do we need to design a budget?

A detailed budget will help you to identify which resources are already locally available and which additional resources may

be required. The process of budget design will encourage you to consider aspects of the work plan you have not thought about before and will serve as a useful reminder of activities planned, as your research gets underway.

How should a budget be prepared?

It is necessary to use the work plan as a starting point. Specify, for each activity in the work plan, what resources are required. Determine for each resource needed the unit cost and the total cost. The budget for the fieldwork component of the work plan will include funds for personnel, transport, and supplies. Note that, unit cost (e.g., per diem or cost of petrol per km), the multiplying factor (number of days), and total cost are required for all budget categories.

Budget justification

It is not sufficient to present a budget without explanation. The budget justification follows the budget as an explanatory note justifying briefly, in the context of the proposal, why the various items in the budget are required. Make sure you give clear explanations concerning why items that may seem questionable or that are particularly costly are needed and discuss how complicated expenses have been calculated. If a strong budget justification has been prepared, it is less likely that essential items will be cut during the proposal review. Sample budget proposal for a typical M.Sc. Project is shown in Appendix VI.

References

The importance of referencing

In the academic tradition, of which research is an important branch, referencing is of utmost importance. Referencing serves a variety of functions. First, referencing is a means of communication and sharing of information. Through referencing, one avails to other members of the academic community and general stakeholders,

step in the research process because those samples selected from the population will now have the opportunity of contributing to the research by providing the data. The research design often dictates the method of data collection.

Methods of data collection

Data collection could be achieved through different methods that are also called techniques. They include observation, interview, questionnaire, mechanical instruments, etc.

Observation

It is the method of data collection that involves watching and noting behaviors or activities of the research subjects that are of interest to the researcher. It is the most applicable method in many types of research that involve performance. With observation, the researcher has a record of what is observed in narrative form, or on a schedule that has some categories, or a checklist that shows the expected behaviors.

Observation is planned, and all the behaviors of importance must be clearly identified and stated on the observation schedule. Observation considers what should be observed, how it should be recorded, how the accuracy will be ensured, and what relationship exists between the observer and the subjects. Clear definitions of the kinds of behavior to be observed will enhance the accuracy and objectivity of the data. The observation could be a participant where the researcher or observer is part of the group being observed, or non – participant where the researcher observes from outside. A participant-observer participates in the group functioning and tries to observe and record information at the same time. In both types, several observers could be used in order to make more objective decisions about some behavior types. In such situations, the observers are carefully trained to sharpen their skills and learn how to use the instruments according

Interviews

An interview is a method that permits face to face contact with the researcher with the subject in order to collect data. The interview could be structured or unstructured. The structured interview: - in which the researcher reads the questions to the subjects from a prepared interview guide and records the answers as they respond, on the guide, or with tapes, etc., as permitted by the subjects. The unstructured interview: - in which the researcher has outlines or areas of the content, but no ready questions as in the guide. The manner of questioning may vary as the researcher can modify, expand or probe more during the interview to obtain the appropriate data. In the event of the researcher needing assistance with the data collection, they must be well trained. The interview requires researchers who are skilled in interpersonal communication.

The Questionnaire

A questionnaire is a set of questions aimed at eliciting data and is self-administered. The questionnaire should be straightforward, in simple language and brief. The questions should be relevant and clear. Questionnaires may be open or closed type. Rating scales are often used to obtain definite ratings on obvious factors. The questionnaires with appropriate control record a high response rate. They are easy to process and easy to distribute. Questionnaires have the advantage of complete anonymity of the subjects and are relatively cheaper to administer. A carefully worded introduction is important for both the questionnaire and interview.

Mechanical instruments

These are very much applicable in applied and pure science research where data is collected through analytical instruments like atomic absorption spectroscopy, gas chromatography, pH meter, voltammetry, and other chemical instruments. How valid the instruments are is determined by the efficacy of the data (measurement they give).

Data analysis and Interpretation of results

Data analysis

Data analysis is the process of summarizing, presenting and describing the data collected from research in such a way that relationships can be established and inferences drawn. Analysis of data is often categorized into the descriptive and inferential analysis based on the statistical methods used. The two major statistical methods used are descriptive and inferential statistics.

Descriptive statistical method

The descriptive statistics are those measures that enable the researcher to describe the data or facts as contained in them. It comprises two major groupings – the measures of central tendency and measures of dispersion.

Measures of Central Tendency: These are those measures that indicate or best represent the whole distribution of data or observations. When the researcher wants to use one score as the typical score, the average score is used, which is the arithmetic average or the mean. The measures of central tendency are the mean, median and mode.

Measures of Dispersion: The measures of dispersion or variation refer to the spread or dispersion of the data. The range, variance, and standard deviation are the measures used for this purpose.

Inferential statistical method

Inferential statistics are the statistics that enables inferences or conclusions to be made in a study about a population or given data from a sample. Inferential statistics are based on the laws of probability. Statistical inferences consist mainly of estimating parameters and testing hypothesis. Examples of inferential statistics include – t-test, Analysis of Variance (ANOVA), Chi-square test, Analysis of Covariance (ANCOVA); to mention but a few.

The correlation coefficient is often called a bi-variate statistics because it can be used as an inferential and descriptive statistics. The t-test is the statistic most commonly used for the testing of hypotheses that applies to differences between two groups, while the analysis of variance procedure can handle three or more groups as well as more than one independent variable. The Chi-square is most frequently used in connection with the hypothesis relating to differences in proportions. Details of the computation of these can be obtained from any standard statistics textbook. You will be provided with some of them in the reading references at the end of the module.

Interpretation and Discussion of results

The interpretation of the results of a study and discussion that follow must be focused on the purpose, research questions, and hypotheses of the study. The researcher is the most suitable to give meaning to the results based on the methods of analysis. The descriptive and inferential statistical results need to be explained and should be presented in tables, graphs or figures as appropriate. The discussion of findings is usually in as simple a language as possible, drawing out all the significant findings in the study, and trying to justify or explain why the result is useful or not. Every research question is stated, and the results related to it presented and discussed. For the hypothesis, each is stated, and then the findings discussed depending on what statistical test was used in the analysis.

Activity 3.3

a. Define a research proposal.

b. List the major sections of a proposal.

Writing the research report

Research reports are given to reveal that the researcher has a reasonable grasp of what went on, how the subjects provided that

data, the extent to which the researcher interacted with the data and the interpretation of the data. The report should have an introduction which details what was investigated, and why; a methods section, which explains how the research was done, the results that show what was found, and discussion which explains what the result means, including the conclusions and recommendations. It should also have an abstract which is a summary of the research that summarizes the study's scope and findings including the purpose, results, conclusions, and recommendations. All the relevant information must be conveyed and at the end, there should be references to acknowledge all the other authors consulted or referred to in the literature review and other aspects of the study. There is also an appendix that shows all the correspondences and instruments of the research. The major areas of the research report, therefore, include the title page; the abstract; introduction; literature review; method; results; discussion; conclusion and recommendations; references and appendix. Details of each part of the research report will be discussed in unit four.

Disseminating results

One of the major expectations in research is that the findings or results need to be shared with others. The process of sharing the findings of the research is called communicating the findings. Research findings could be communicated in various ways, to different groups or audience depending on why that research was conducted. It could be communicated in an educational institution, to an academic audience, in partial fulfillment of the requirements for a degree, or diploma, etc.; or for publication in a journal; or could be communicated to a live audience at conferences, workshops, etc. For each of these, there are guidelines usually provided by such bodies about how to write the research report, and which must be adhered to for the work to be accepted. Unit four will introduce you [illegible] and communicating research findings.

3.6. Unit Summary

- There are criteria necessary to determine researchable problems.
- A literature review is an important step in the research process.
- A literature review will help the researcher to identify what has been written about the area of interest.
- There are primary and secondary sources of literature.
- The search methods include print and electronic, examples of which are abstracts, indexes, computer-based resources – internet, etc.
- A research proposal is the written plan for the research project.
- A research proposal presents and justifies a research idea and the practical ways in which it can be solved. It analyzes and synthesizes the existing research about a particular topic and describes the writer's own idea for a new study, based on the assessment of gaps or problems in the research literature. More precisely, a proposal is a demonstration of a commitment to an extensive study.
- The major components of a research proposal include title and cover page, literature review (background), objectives, material and methods, work plan, budget, and references. It lacks result, discussion, and conclusion sections.
- Data collection is the step in the research process where the researcher makes contact with the subjects in order to collect the relevant data.
- Data analysis is the process of summarizing; presenting and describing the data collected from research in such a way that relationships can be established and inferences draw.

- Interpretation and discussion of findings is an important step in the research process.
- The discussion of findings must emphasize what was the major finding, and how the variables are related, drawing out implications of the findings, and how they could contribute positively or negatively.
- Communicating research findings is an important step in the research process that reveals what was done to others.
- Research reports should be written in simple and clear language.

3.7. References/Further readings

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- Chris AM (2018). How to Write a Good Scientific Paper (ISBN 9781510619135). SPIE PRESS Bellingham, Washington 98227-0010 USA.
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- Frank, P. The elements of a proposal. Emory University Guide on how to write a good research proposal.
- Hofmann AH (2009). Scientific writing and communication: papers, proposals, and presentations.
- Karathwohl DR (1988). How to prepare a research proposal. Guidelines for funding and dissertations in the social and behavioral sciences (3rd edition). New York, Syracuse University Press.
- Marder MP (2011). Research Methods for Science. University of Texas, Austin.

❖ Recommendations for the Conduct, Reporting, Editing, and Publication of Scholarly Work in Medical Journals (2017). ICMJE.

Available at:www.medicc.org/medicreview/documents/ICMJE

❖ Reid CPP (2000). Handbook for Preparing and Writing Research Proposals. Publication of IUFRO-SPDC, 164 pp.

❖ Steneck NH, United States (2007). ORI introduction to the responsible conduct of research. Rockville, Md.: Dept. of Health and Human Services.

❖ The Concordat to Support the Career Development of Researchers 2008)- An Agreement between the Funders and Employers of Researchers in the UK. Careers Research and Advisory Centre (CRAC) Limited.

3.8. Unit Exercise

1. One of the following may give rise to a research topic.
   a) One's own experience
   b) A scientific literature
   c) Scientific theories
   d) A and B only.
   e) All of the above.

2. One of the following can be considered as a criterion to choose a research topic.
   a) Current interest in the topic
   b) Availability of literature relevant to the topic
   c) Accessibility of the required data
   d) Amount of time and cost available
   e) All of the above.

3. Which one of the following is a method of recording notes on scientific articles you read?

a) Paraphrasing
b) Summarizing
c) Use of quotation
d) a and b only
e) All of the above

4. A research proposal is

a) It is a plan of action that contains all the key elements involved in the research process.
b) It is a concise written plan of the research you intend to undertake.
c) It is the written plan for the research project.
d) It is a detailed description of a series of activities aimed at solving a certain problem.
e) All of the above.

5. One of the following is included in the material and methods sections of a research proposal.

a) Sample preparation techniques
b) Origins of samples and materials
c) Statistical analysis techniques used.
d) Descriptions of equipment set-up and function
e) All of the above.

6. A budget preparation will help to:

a) Identify resources which are already locally available.
b) Identify resources which may be required.
c) Encourage researcher to consider aspects of the work plan you have not thought about before.
d) Serve as a useful reminder of activities planned, as your research gets underway.
e) All of the above.

7. Which one of the following statement describes the purpose of literature review in research?
   a) Gathering information to learn about a specific subject topic.
   b) To demonstrate an understanding of the relevant works others.
   c) To be familiar with different research methods.
   d) To avoid exact duplication.
   e) All of the above.

8. One of the following can be used for conducting a literature review.
   a) Using keywords of the topic
   b) Using phrases of the topic
   c) Using the author(s) names
   d) Skimming of books and journal articles
   e) All of the above.

9. Which one of the following is not a section of a research proposal
   a) Introduction/Background and justification
   b) Work schedule, budget schedule, and reference
   c) Material and methods
   d) Result and discussion
   e) All of the above.

10. One of the following is included in the material and methods sections of a research proposal.
   a) Sample preparation techniques
   b) Origins of samples and materials
   c) Statistical analysis techniques used.
   d) Descriptions of equipment set-up and function
   e) All of the above.

11. A work plan may include
    a) The tasks to be performed
    b) When and where the tasks will be performed and
    c) Who will perform the tasks
    d) The time each person will spend on them.
    e) All of the above

12. A budget preparation will help to
    a) Identify resources which are already locally available.
    b) Identify resources which may be required.
    c) Encourage researcher to consider aspects of the work plan you have not thought about before
    d) Serve as a useful reminder of activities planned, as your research gets underway.
    e) All of the above.

13. One of the following is true about referencing.
    a) It is a means of communication and sharing of information.
    b) It facilitates handy retrieval of information for use at another time.
    c) It is one of the main components of a research proposal.
    d) It is used to cite materials under the literature review section of a proposal.
    e) All of the above.

14. Which of the following statements describe the purpose of an abstract?
    a) To states the purpose, findings, and impact of the work.
    b) To summarizes the main sections of the paper.
    c) To assess the relevance of the work
    d) A and B only
    e) All of the above.

UNIT FOUR

COMMUNICATING RESEARCH FINDINGS

4.1. Introduction to Scientific Communication

This unit will introduce you about the different ways used for communicating research findings. One of the major expectations in research is that the findings or results need to be shared with others working in the same/related fields. Thus, researchers need to share their findings. Research findings could be communicated in various ways and to different groups or audience depending on why that research was conducted. The different ways in which researchers can communicate their work include written presentations (like papers/ articles in scientific journals, reports, conference and abstracts, graduate and postgraduate theses, reviews, proposals, popular science articles, newspaper and magazine articles, brochures, leaflets), oral presentation and poster presentation. In this unit, writing a scientific journal article, oral and poster presentation will be discussed.

4.2. Unit Objectives

At the end of this unit, you should be able to:

- Describe the concept of communication of research findings
- Be able to communicate research results/findings to end-users
- Prepare a range of different styles of scientific presentations
- Describe the major sections of a scientific article
- Improve scientific writing skills to produce publishable papers
- Prepare a scientific oral and poster presentation

- Assessing and determining relevant material for scientific presentation
- Select and prepare the most appropriate way to present your results
- Use and record reference articles in a correct, clear and efficient way
- Utilize references and appendices as appropriate
- Write a full article for publication, with each section being clear and concise

4.3. Writing a Scientific Paper/Article

A scientific paper has been defined as "a written and published report describing original research results." The watchwords of scientific writing are clarity, brevity, and organization, which are essential because scientists usually read scientific literature for information and not entertainment. Thus, your task as an author is to convey information quickly, yet clearly, understandably, and concisely.

Writing a scientific paper is one of the major ways of communication of new research results and it is a final product of all researchers. A scientific paper should be original documentation of research results and requires precision. It should be logical and clear (others can repeat and check) and always give reference to the original source. It should be structured (organized) into major sections. This structure enables readers and peers researchers to determine the need for that particular piece of research to be carried out, the materials that were used and the way the research was done, the findings of the research itself, and the significance of the findings in relation to current knowledge.

The writing most researchers do is writing journal articles and Most likely these articles are submitted for publication in printed journals but it could also be for electronic journals which are now being published 'on-line'. Writing scientific articles for an international

journal (for publication in journals) is a skill that, like any other skill (skills originally needed to carry out the work being reported), requires practice. The more papers you write, the easier it is to write them. Writing the first paper is however the most difficult part of acquiring this skill and beginner needs to develop scientific writing skills. We hope this unit will help you to overcome that barrier and give you the courage to write your own paper, submit it to an international journal and eventually become successful in scientific writing.

In order to write an article, the assumption is made that, you have already completed some studies of one or another kind and that the data have been analyzed. You may not yet, though, have put the data together with all the other information you have in the shape of a scientific paper. This unit can then be used as a guide to help you assemble your research results into an article and to submit this article for publication in an international journal. In general, to write a scientific article, first you have to choose a journal appropriate for your paper and then read the current version of its Instructions to Authors- a set of instructions intended to allow authors to use the same format and style for papers submitted to different journals. This guideline allows you to format the paper appropriately from the beginning and avoid wasting time later. Several journals print these instructions in every issue, others only in the first issue of each volume. They also appear on the website of the journal. However, although formats and styles vary from time to time and journal to journal, a scientific paper should be written in a clear, concise, and organized style following instructions to authors of the journal you wish to publish your article. Thus, writing a scientific paper for an international journal (for publication in journals) requires both a sound understanding of the form of a scientific paper and a clear, compact writing style.

4.3.1. A General Format of a Scientific Paper

It would be useful at the very beginning, though, to make sure [illegible] the basic structure of a research article. This

structure enables a reader to determine the need for that particular piece of research to be carried out, the materials that were used and the way the research was done, the findings of the research itself and the significance of the findings in relation to current knowledge. A standard/conventional format is used for almost all scientific papers, in any discipline (as well as M.Sc. and Ph.D. theses also) are structured along the same basic lines, into:

- Title
- Author
- Abstract
- Introduction
- Methodology (Materials and Methods)
- Results
- Discussion
- Conclusions and recommendation
- Acknowledgments
- References

Activity 4.1

a. What is mean by communicating research findings?

b. List the ways of communicating research findings.

4.3.2. The IMRAD structure

The standard structure of a scientific article is often referred to by its initials: IMRAD. The acronym IMRAD stands for Introduction, Methods, Results, and Discussion. The acronym IMRAD structure of scientific publications is based on the following arrangement:

Introduction - Why did you do the research?

Materials and Methods - What did you use and how did you do it?

Results - What did you find?

And

Discussion - What do these findings mean?

While all scientific research articles share a common organizational setup, you will find variations within articles. The common

organizational structure of the article is to ensure ease of reading. Researchers must quickly filter the huge amount of information available in scientific publications. It helps readers move quickly through articles. Therefore, the main substance of a scientific paper is contained within the four sections of the IMRAD acronym. These headings will be addressed again in more detail in the following sections.

There are, of course, many other sections, like the Title, Abstract, References, and Acknowledgements, which also are necessary, before you can submit an article to a journal.

Title and title page

Most journals require a separate title page that includes

- The full title, to be used at the head of the article
- The running title, an abbreviation of the title that appears at the top of each page in the article when it is printed
- Keywords that can be used to identify the paper in the index of the journal
- The list of authors in the order in which they should appear
- The affiliation of the authors, this means the organization where the work was done, a university, a hospital or a research institution, for example
- The address for the corresponding author, the author who is responsible for all of the contact between the authors and the journal. This will usually be the name and address of the senior author, but often one of the other authors will be appointed as responsible for correspondence, especially if for example the senior author is moving, or is not easy to contact because he/she lives in a remote area. The address for the corresponding author should include the mailing address (a box number for example), the physical address (this is often needed by international couriers), the telephone and fax numbers, and if available an e-mail address.

Title

The title is a key part of the article that tells a potential reader what information they are likely to find in that article – it is probably the most widely seen and read part of the research paper. Thus it should contain all the keywords of the paper. The title of a research paper should accurately and adequately describe the subject and contents of the paper in as few words as possible. It should generally describe the subjects of the work, not its results.

The title should include the name of any plants or animals, either as common names (if these exist) or scientific names, or both for lesser-known species. If the work and its conclusions are restricted or relevant to a particular region this should be named (e.g. sub-Saharan Africa; the Indus Valley). The title should avoid abbreviations, formulas, brand names, and unusual terms. A title should not have dates. A title should avoid unnecessary words and phrases, such as 'Observations on', 'An investigation into', etc. A title is often best written after completing the paper. It may even be the very last thing to be written! A good title

- Should attract people to your paper
- Should tell what the paper is about
- Should be informative, specific and concise
- Should describe the subject of research and not the results
- Put the most important words first
- Describe the novel material used—to differentiate your research from others on the subject
- Limit the title to not more than 7–10 words
- Make sure that the final title is relevant to the content of the paper

Author(s)

In principle, the authors of a research paper or article are those who have contributed substantially to the conduct of the research and the preparation of the research article. This may include an intellectual contribution; for example supervisors of research papers arising from M.Sc. /Ph.D. theses. Names of authors should be complete enough to ensure proper identification. If there are authors with the same surname or family name, it may be necessary to add full names instead of initials. Names of authors should be listed in a logical sequence. This usually means that the major contributor to the research work and the writing of the research paper is named as first ('senior') author, with other authors following in decreasing order of their level of contribution to the work. If there are many authors, with broadly equal levels of contribution, an alphabetical listing may be used. If an alphabetical listing is used include addresses of all the authors, following the journal style. Questions and queries ('correspondence') concerning the research paper by future readers would normally be sent to the senior author. If for some reason this is not the case and correspondence should be sent to someone other than the senior author, this should be indicated. The address for the corresponding author should include the mailing address (a box number for example), the physical address (this is often needed by international couriers), the telephone and fax numbers, and if available an e-mail address.

Abstract

An abstract summarizes the major aspects of an article. It is usually one paragraph long, and should succinctly summarize the purpose of the paper, the methods used, the major results, and interpretations and conclusions. This means an abstract should follow the IMRAD structure, but it should be written as a single paragraph. Abstracts are of major use in enabling others to quickly and easily decide if they wish to read the full paper. It must contain enough information for them to understand the work and for them to decide whether it applies to their project or not. Thus, readers can assess the relevance

of the work simply by reading the abstract. For this reason, try to convey as much information as possible to have the greatest impact. Always find a way to say clearly what you found to be important using the least number of words. Most journals put a strict limit on the number of words you can use in an abstract, and you must stick to this. It should be written after the investigations and the whole article are completed. Abstracts should stand alone, below the title or at the end of the article. In general, an abstract

- Abstracts are read on their own
- Read by most people and often it will determine whether they read the entire paper
- Should describe the problem and summarize the major points of the research in a brief and understandable form
- Start with
  - A clear statement of the objectives
  - Approach
  - Main results
  - Should end with one or two sentences that emphasize important conclusions
- Depending on the journal, the length of the abstract is restricted to the maximum number of words
- Should stand alone
- Do not cite references to literature, tables and 'figures'
- Avoid using abbreviations
- Use the same tense throughout the section or at least throughout a paragraph. It is normally written in the past tense.

Keywords

They are a list of important words (or short phrases) used in the main text or abstract. Keywords are provided below the abstract. These are used for the indexing and reference systems that provide cataloged information both in the journal itself and in abstracting services that include that journal. So, choose the keywords carefully so that someone might use to find your article on such a system, such as the name of the study species, the study site, the study type, the methods you used, etc. In general, the number of keywords is not strictly defined (at least 5 - 10 on average), but they should represent the content of the paper in the best possible way and can be listed in alphabetical order below the abstract. To sum up, the title, abstract and keywords are of great importance when providing fast, precise and quality selection of literature. That is why these parts of articles must be conceived and written according to established principles in order to present the whole paper in the best possible way. These parts of articles have a significant role in scientific communication.

Activity 4.2

a. What is the acronym IMRAD stands for?

b. What to include in the introduction section of a scientific paper/article.

Introduction

A scientific article needs an introduction, though it is sometimes broken down into different components. The length of an introduction depends on the journal and the types of an article; however, the structure and content should be similar. An introduction should provide the reader with all the information he/she will need to understand the rest of the paper. In the introduction, you must present a summary of the problem to be investigated, give background information on the problem, state the objectives of the study, describe the significance of the study, review relevant studies

by other researchers, describe and justify methods used, discuss previous research done on the topic, and point out where there is a gap in our current knowledge, and how the study you have done addresses this problem.

The purpose of the introduction is to explain to the reader why you did the research investigation at all. It is very important in the Introduction to show where there is a gap in our current knowledge, and how the study you have done addresses this problem. The research question must be very clear to any of the readers of the article, and the question should be based on existing knowledge, data, and reports using appropriate references. Point out where there are gaps in our knowledge or where there are conflicting results that need to be resolved. The 'Introduction' sets the problem in the context of current knowledge and should move from describing the general setting to describing the specific situation. Any specialized terms or abbreviations should be explained in the 'Introduction'. A key section of the introduction is the listing of your objective(s).

These will often lead logically to a suggested hypothesis. The 'Introduction' is also the place for a broad description and justification of the method(s) you have chosen. The introduction should contain all the background information a reader needs to understand the rest of the author's paper. This means that all important concepts should be explained and all-important terms defined. In the introduction, you do not need to make an extensive review of the literature but you should keep it short and simple. The usual number of paragraphs in the introduction in most journals is two to four – so this is what you should be aiming for. In writing the introduction it is very important to have the right flow of information to show clearly how the study itself fills an important gap in scientific knowledge. This flow of information is often the most difficult part of the writing and it is a skill that, like any other skill requires practice. A specimen title page that shows the title, abstract, keywords, introduction and authors of the research is shown in Appendix V.

This section of the research paper describes how the study was conducted specifically focusing on a project plan, experimental design, materials used, methods for making an observation, data to be collected and how analysis of the data will be done.

The purpose of this section is to let readers know exactly how the study was carried out so that if desired it could be repeated. The purpose of this section is to make it possible for interested researchers to repeat the experiment/study and reproduce his/her results. Thus, you must describe exactly what you did as closely as possible in the order you did it. This makes it much easier for a reader to follow the methods you used and anyone could repeat the experiment/study and reproduce his/her results. This section is often quite lengthy, and in some journals, the "Methods" section is printed in smaller font size than the rest of an article. The usual number of paragraphs in Materials and Methods in most journals is six to eight, and subheadings are often used in these journals. This section is conventionally written in the third person, passive construction throughout, and always uses the past tense. For example: "The sample was heated to 90 °C for 30 seconds." - NOT: "I heat the sample to 90 °C for 30 seconds."

If you are reporting a completely new technique, this must be described in such a way that others can follow that technique as well, and so some detail is necessary. If you are reporting standard, recognized techniques where the technique or procedure has been described in a recognized journal is sufficient there is no need to describe these procedures in detail. The name of the technique, plus a reference that does describe the method in detail is quite adequate. For example: "Samples were prepared using the same process as described by Newton et al. (2000)."

If it is a modification, however, both the reference for the original method and a description of the modifications you made are needed.

Describe the study sites in terms of their characteristic feature, then everyone can understand why those sites were chosen. Subjects used should be identified accurately usually by genus and species. You do not need to provide detailed descriptions of simple processes such as measuring/mixing/applying samples. Simple details of the quantities applied and method(s) of application are sufficient. Be sure to describe any modifications to equipment. All names and abbreviations used should be clear and understandable and all measurements should be presented in internationally recognized SI units and notation. If you are using a particular kit, or special reagent the source (Company name and country is usually enough) should be given the first time you describe it. Avoid trade names; use the chemical or generic names of equipment and chemicals so that people in all countries can understand what you mean.

You should include all the details of experimental design and statistical analysis. As with equipment and chemicals, ordinary procedures (e.g. ANOVA, chi-square) can be used without comment. When you write this section, some of the points you need to consider includes:

- Subjects used (animals, plants, humans) and their pre-experiment handling and care (anything that might affect the results must be included)
- Description of sample size and how samples were selected
- Sample preparation techniques
- Origins of samples and materials (e.g., "Twenty-one 18-year-old students from the Psychology 101 class at the University of San Diego in California")
- Description of the study site (if applicable) including physical and biological features, and exact location (include a map, if applicable)

- Protocol for collecting data - how were the procedures carried out?

- Description of Statistical analysis techniques used. If used (for example, in ANOVA tests), the author must report the threshold used to determine statistical significance.

- Descriptions of equipment set-up and function

Results

This section presents the outcomes of the study without interpreting their meaning. These outcomes are directly related to the objectives outlined in the Introduction section. Hence, the purpose of this section is to report what you found. The Results section is often the shortest section of a research publication, but also the most important. It differs from most of the others, in that it contains both text and graphic material, such as figures and tables. Tables and figures are good tools to make your results easy to read and understand. But you also need to state your results clearly in words. A table or a figure enables readers to see the summarized data for themselves, but the results remain the subject of the text, not the tables or figures.

As with the methods section, the result section is written in the past tense and in most journals, in the passive case. You should state the results of statistical analyses in this section, but should not describe every detail of the analysis. Do not feel that all data and results should be included. Be selective, presenting only that which is relevant to making the conclusions that you will present in the following 'Discussion' section. The results you do include should clearly describe what was found, including statistical tests, differences, and probabilities. Statistical significance is reported in the 'Results' section. However, the interpretation of scientific importance or significance is not; this is done in the Discussion and /or Conclusion section(s).

In general, the results section should not include references, since you are describing what you found in your study. Any comparison with other findings belongs in Discussion. The other main requirement of the Results section is honesty – report what you found even if it doesn't fit with a pre-existing hypothesis. Make sure that the arrangement you choose fits with the journal to which you are planning to send the article. If there are few data to present, it may be best described in text form only. The text uses less space and many journals limit the number of tables and figures. A common mistake is to describe in the text the same information that is shown in a table or figure. It may be acceptable to describe in the text the highlights of the table or figure, but duplication is something that editors dislike intensely.

Data presentation

For each set of data, you must look for the best way to present it. The presentation of the data must be as clear as possible. Each figure or table must be understandable independently – that is without having to go back to the text. To achieve this, you must select the most appropriate way to show the data, in a table, chart or graph so that the reader can see the data and understand what it means.

Tables

A table presents lists of numbers or text in columns and should be used to illustrate differences, but not to represent relationships. Tables are useful for presenting analyzed summary data (e.g. means ± standard errors). You can use them to show precise figures, as well as other (non-numeric) details, including words or symbols, to indicate location, treatments, variety, etc.

Each table generally has a separate table number. The number and present your tables sequentially, in the order in which they are referred to in the text. If you have many tables presenting related data, use the form Table 1.1, Table 1.2 rather than Table No. 1a, Table 1b, etc.

A table should have a clear and concise title which tells what the table shows, not what the table is about. Place your table numbers and titles above each table. Here are the key elements of a good table:

- A table has column headings, which should be short and easily understood.
- A table has row headings (or stub headings).
- A table has a field, the 'boxes' of information in the body of the table.
- A table often has footnotes, either to explain any abbreviations or symbols being used or to provide a Reference if the table (or field items within it) are taken from a source other than the Results being presented.

Do not put too many items on a table, because it will become cramped and hard to interpret. If you have too few items, the table may be unnecessary. If you have less than eight field items, you probably do not need a table and you can present the results as a text. A table should include the same group of elements down columns, and not across rows. However, columns with the same value throughout should not be included. If a column has the same value all down its length (and if the value is needed) it could perhaps be better included as a footnote. To make your tables easy to read, do not separate the columns with vertical lines. In summary, tables should be able to stand alone, be self-explanatory (with their title and footnotes), and help to convey the results of the experiment.

Figures

A figure is any visual presentation of results or illustration of concepts/methods, including graphs, images, diagrams of set-ups, drawings, maps, etc. Figures should be numbered separately from tables (i.e., a paper can have both a Table 1 and a Figure 1) and

referred to by number in the text. As with tables, present and number your figures sequentially, in the order in which they are referred to in the text. Also, as with tables avoid Figure 1a, Figure 1b, etc. and use Figure 1.1, Figure 1.2. Like tables, figures need a clear and concise title, which tells what the figure illustrates and allows the reader to interpret the figure without referring to the text. Notice that unlike with tables, the numbers and titles of figures are placed below the figure. For inclusion in a research paper a figure should be:

- Simple, clear, and visually attractive—not crowded
- Stand-alone (with its titles and any footnotes)
- Easy to understand without the need to refer to any other part of the paper

A figure should be simple enough to get the message across instantly. The inclusion of too much detail may just create confusion. Figures should be in black and white if possible. Color and grey shading can look good but add to costs. Changes from the original colors may occur during the printing and cause further confusion. If axes are used they should have brief informative titles (legends) and include any units of measurement. Axes should not extend much beyond the range of the data. If needed, the items in a figure should contain simple and relevant legends. Remember, results may be presented as either tables or figures, never as both. Each table and figure should be submitted on a separate page, with a title (table) or legend (figure) that clearly and accurately describes the content. Make sure that the figures you submit are printed clearly and cleanly.

Discussion

This section of a scientific paper contains an interpretation of the results. You should interpret results clearly, concisely and logically. Thus, the purpose of this section is to analyze and interpret the results reported in the previous section and showing how they have

answered the questions set out in the Introduction. It should answer the questions:

- What do you think is the meaning or significance of the results? If you asked a question in the introduction and your results answer the question, then that is the main point of your discussion.
- What are the limitations of the study, and how may this affect the conclusions reached?
- How do these results compare with others in the literature from similar or related studies?
- If there are differences or unexpected results, what are the possible explanations?
- What are the implications for future research?
- What are the conclusions that can be applied now and what must be done to apply them?

Basic structure

The discussion must be long enough to present the argument for your conclusions, but it must not so long that the reader will give up. Six to eight paragraphs should be sufficient. As with all of the other sections of an article the discussion should flow logically, and not jump from one argument to another without some connection between the paragraphs. A fairly typical sequence would be:

- A short introduction to summarize the context and purpose of the study.
- A summary of the main findings without the need for exact data, or p-values.
- A discussion of how this compares with other findings in similar studies, with some suggestions for reasons why your findings differ from previous studies if they do.
- A short description of any limitations in your study
- An indication of the potential value or significance of your findings.

Note the following as you begin to write the discussion section:

- Cite evidence from the literature that supports or contradicts your results and explain contradictions. Describe the limitations of your research. Results or references to tables or figures already described in the results section should not be repeated in the discussion.
- You should not include in this section material on the research background and scientific context. This information is set out in the 'Introduction' and should not be repeated. Nor should you repeat the questions your work is attempting to answer—these too should be shown in the Introduction.
- Sometimes you will include in the 'Discussion' section shortcomings, errors, inadequacies, or difficulties encountered during the research.
- This is also the section for pointing out how your results compare with the findings of others and explaining any differences from previously published research.
- The discussion interprets and draws theoretical principles and generalizations from the results. But you should avoid proposing principles and generalizations beyond what is directly supported by the results.
- You may wish to conclude the discussion section with some broad generalizations and speculations, based on the results and other (published) work (with references).
- You may also end this section by identifying further problems and the next steps and additional research needed.

Conclusion

Very often you will not need to write a conclusions section, because you will have already stated your main conclusions in the final section of the discussion. You should certainly never include a conclusion just to repeat what you have said in the discussion

However, if your results and the subsequent discussion have been especially complicated, and you may well want to include a separate 'Conclusion' section to bring all your findings together in a consolidated whole. If so, you may begin this section with a very brief summary restatement of the major results and highlights of the 'Discussion' section as they relate to future needs and activities. Before preparing a separate 'Conclusion' section, check on the style and format instructions to authors of the journal to which you are planning to submit your paper. In the previous sections, we have covered each of the major parts of a standard research paper, following the IMRAD structure. There are, of course, a number of other factors that have to be considered before a paper is submitted to a journal.

Activity 4.3

a. Compare the results and discussion section of a scientific paper.

b. Describe the types of citations.

Acknowledgments

This section of a scientific paper consists of a short paragraph thanking individuals or institutions who have contributed to the work. It is the place to mention financial support from internal or external sources, as well as help that you received from people who provided materials or samples, or who carried out an important part of the study. It is usual to acknowledge the assistance of a technicians, a supervisors, colleagues who gave advice or with whom you discussed ideas, statisticians who helped with the analysis and interpretation of results, outside institutions or companies that supplied equipment or facilities or financial assistance, as well as special facilities provided by a company, university or research institution. Particularly in studies carried out in specific communities, you may wish to thank the people from that community who contributed their time, perhaps physical samples or other contribution they made to the successful implementation of your study.

Always ask the person permission to publish this acknowledgment and don't forget to include donors in your acknowledgments. Give the name of the agency, the name of any large program of which the work forms a part, and perhaps a grant code or number. If the work derives from a thesis not referred to in the text, this can be mentioned in the acknowledgments.

References (Literature Cited)

References usually appear in Introduction, Methods, and Discussion, and this is one area that differs greatly from one journal to another. References may be used either in explaining and justifying the need for the work (those text citations generally in the 'Introduction'), the conduct of the work (those text citations generally found in the 'Results' section), or the implications of the work (those text citations generally in the 'Discussion' section). The purpose of the references is to provide a way for the reader to obtain background information that you do not give in detail in the paper. It is also enabling other researchers to trace and obtain any previously published research used to describe and support the new work being presented. Each reference should serve this purpose – if you make a statement or refer to other work related to yours, you must give a reference. That reference should be published in a journal or book that is accessible to the reader.

- Follow the recommended format of referencing by the journal to which you are going to submit your article or the referencing format of thesis/dissertation required by your institution or university.

- You should limit the number of articles cited to the minimum that serve the purpose. Many journals have a limit on the maximum number of references that are allowed (usually 20-30) and you must not exceed this. If you are likely to reach the maximum limit, delete some less important references. Ensure that, unless absolutely necessary, references include

- Provide acknowledgment whenever another researcher's work is included in the paper

4.3.3. Writing a Master's Thesis

The M.Sc. (Masters of Science) is a second university degree. It is acquired after writing a Master's thesis and defending it at an oral examination. There are almost no generally accepted rules for thesis preparation. Thus the structure of the thesis is different from journal articles. However, the broad structure listed here is the essential elements of a thesis in the order in which they should normally appear.

- The cover and title pages
- Candidate's declaration
- Abstract
- Dedication (optional)
- Acknowledgments
- The table of Contents
- List of figures
- List of tables
- Nomenclature/list of acronyms
- Introduction
- Objectives
- Literature review
- Materials and Methods
- Results
- Discussion
- Conclusion and recommendations
- References
- Appendices

4.4. Oral Presentations

Giving oral presentations at a suitable scientific meeting (conference, seminars and workshops, project planning and donor meetings), frequently as short as 10 minutes, is one way of disseminating research results. It is the most common way to communicate your results to others (peers, decision-makers administrators, donors, the general public, or other stakeholders), and to obtain the criticism that will improve both your research and subsequent paper(s).

Preparing oral presentation for a scientific meeting is a skill, requiring both experiences in public speaking and training to present material clearly and effectively so that the audience can understand and learn from the information being communicated. As a result, much effort is needed to prepare it (well in advance), along with the associated visual aids, usually by slides, overheads, or PowerPoint according to the general rules and specific requirements of the organizers of the meeting. The preparation consists of three main items: the selection of material to be presented, organization of the presentation, and preparation for the question-answer section. Remember that, in order to give oral presentations at a suitable scientific meeting (conference, seminars and workshops, project planning and donor meetings), an abstract must be submitted and accepted for oral presentation at the conference. Thus, your abstract must conform to abstract guidelines specified by the conference organizers in order for your work to be accepted for oral presentation.

4.4.1. Preparing an Oral Presentation

The major section of preparing an oral presentation includes preparation phase, organization of the presentation (speech) and the question and answer session.

Preparation phase

It starts with the selection of results to be presented. It is important to limit the amount of material and to explain fully this limited number of points. These two rules enable the speaker to concentrate to main results and adjust his talk within the allotted time - which is prerogatives for effective communication.

Organization of the presentation (speech)

It should include a description of each part of the project — from how the idea originated, through the literature search, the formation of the question or problem, the hypothesis, experimental design, results, analysis, conclusions, and future applications — is important

to relay to the listener. It basically follows the logical pathway of a written article, i.e., using the IMRAD formula (Introduction, Methods, Results, and Discussion), with two important exceptions. Firstly, the Methods section usually lacks details required for written paper or even may be completely ignored. Secondly, it is not necessary to provide a long list of references; you probably shall mention a couple of authors while presenting (and simultaneously discussing) your results, thus relating your study to that of other researchers.

The general format for the organization of an oral presentation includes the following major sections:

Title

The title should be short and clear and it must adequately describe the research project.

Introduction or Background

At the very beginning, try to attract the attention of the audience with a couple of introductory sentences, which should explain why the study was undertaken. Keep this attention by a clear explanation of the aim of your investigation, e.g., what problem you are addressing.

Methods

How you did the study would be rather shortly explained, details of which you may give in the Questions and answers section, should it be needed.

Results and Discussion

The Results section (what you found) is the most important part of the presentation: it usually takes approx. 80% of the allotted time. During the presentation of results, discuss them simultaneously, i.e. explain how your results fit (or not) with other people's published evidence. This is the best way to keep the attention of the audience alive.

Conclusion

Finally, you shall clearly state the conclusions (one or two, no more!) you have drawn from your investigation; in the same time, you may emphasize whether or not your prior hypothesis stood up to your test, should it be modified or even abandoned. In short, it is important that you orient your talk around one central idea; therefore, the scope of your subject should be restricted. The amount of material you present should be limited. You are expected to distinguish between big points and the little ones; basic points should be emphasized, explained thoroughly and presented vividly.

The question and answer session

It is often the best part of an oral presentation. It serves the audience to clarify points or add to their knowledge of your subject. It is also an opportunity for the speaker to surmise the strengths and weaknesses of his research; in addition, the questions posed by the interested and knowledgeable colleagues will certainly improve his communication skills.

During the preparations, try to predict what questions might be asked about your report; these might be the same pose on previous occasions you have used to discuss your results (departmental seminars, discussions with collaborators, job interviews, grant proposals); prepare your answers accordingly. When answering the questions, it is important to maintain a professional attitude. That means that you listen closely to the question, repeat it aloud if it is not heard or understood, pause a few seconds to think, and then answer briefly and directly. Your clear and concise answers allow others to ask about something else. If you think that the question deserves answering beyond a reasonably short time, you can suggest colleague meet after the session in order to discuss the matter further.

Do not be afraid to say, "I don't know", if the question is unrelated to your subject. You can refer to the literature as a source for an answer, but don't guess!

4.4.2. Visual Aids

You will probably facilitate you are conveying the message by using slides, overheads, or PowerPoint. The slides are one of the primary communication tools; they enhance verbal communication and enable the audience to concentrate on important items. To be effective, your slides must be brightly lit and convey a simple thought. Bad slides can ruin your speech; few simple rules will help you to make a success of your presentation:

- One slide - one message
- One slide - one minute
- Textual slide - no more than six lines (less is better!)
- Legibility - must be visible and legible from the last seat in the hall!
- Simplicity – success
- Coordination with the speech
- Good composition of word slides, photographs, figures or tables.
- Avoid tables, unless they are necessary and simple
- Quality - clear, attractive, and aesthetically pleasing

The slide presentation must be coordinated with the speech: the slide supplements what the speaker is saying at the time the slide is on the screen. The text on the slide should never be read verbatim but explained with other words. Coordination of the speech and visual aids reinforces the main points of the presentation: the same message, received by two senses (eye and ear) is better understood. Visual aids also help compensate for language barriers on international

4.4.3. The Audience

It is important to consider in advance whom you are talking to. The audience may consist of experts in a specialized field, or be more heterogeneous; you should prepare your presentation accordingly. This means that your presentation should be pitched at a more general level if you are speaking to a diverse auditorium. Anyone who listens has the right to understand your words; therefore, unless you are addressing a small group of your own research peers, try to avoid technical jargon. The same is true for the use of abbreviations. You are obliged to respect and to be considerate to your audience. Many of them have traveled long and spend money to attend the meeting - and to hear you, among others. Do not waste their time. First of all, give your speech within the allotted time (typically, no more than ten minutes); several minutes overtime is inexcusable. Do not speak too fast; slowdown is a leading rule. This will facilitate the conveyance of your message to persons whose native language is other than the official one.

Below are some key points to a good presentation

- Be positive and confident about your work. You have worked hard and know your project better than anyone else.
- Practicing ahead of time in front of a mirror, family members, friends, your class, or others before a presentation.
- Try not to read from a script.
- Look interested in what you are doing. The audiences want to know what you have done and what you have learned.
- Leave gum, CD Players/MP3 Players, Cell Phones, Laptops, and other distracting materials at home during the presentation.
- Dress appropriately and neatly. Wear comfortable shoes.

- Keep eye contact with your listeners during your presentation.
- Use your visual aids as a prop and tool to help you present your work.
- Present your work enthusiastically. Make certain you guide the audience through your project. Have notebooks and reports in clear view and refer to them in your presentation so that the audience will be cognizant of the amount of time, work, and effort you have invested in your project.
- If there is a judge, learn the judge's name (ask for it if he or she does not have a nametag), and address the judge using his or her name. Learn from audiences by asking them questions, or asking if they have additional information or suggestions that you might consider. Be sure to record any suggestions that they give you.
- Answer all the questions that you can. If you are not certain of an answer, you might say, "I'm not certain, but I think it might be." If you do not know the answer, you might give the person an idea of how you would find an answer to the question. It is also appropriate to say something like, "That was not part of my research or experimental plan." You might ask the person if he or she knows and could help you.
- Incorporate new materials from suggestions into your presentation. Practice again before moving on to another level of competition.

Activity 4.4

a. List the three main phases of an oral presentation

b. Distinguish between oral presentation and poster presentation

4.5. Poster Presentation

Posters are display boards in which researchers show their results and describe their experiments. It is viewed as a medium for presenting research results at scientific meetings. In fact, the poster represents a combination of characteristics of the oral and writing form of presentation of research results, which enables interaction between the author and qualified audience. Apart from oral presentation, poster is another common way to communicate your results to others at scientific meetings/conferences and it has become more common and meaningful part of many scientific meetings as a result of increased interest for attendance at scientific meetings and thus the pressure of an increased number of papers for presentation, and lack of time for oral presentations. It is currently accepted that poster can be an efficient way of presenting information and data; moreover, many people have now come to believe that some types of research data can be presented more effectively in poster graphics than in the 10 minutes- confined oral presentation. Furthermore, the poster exhibit can be an effective means of facilitating informal dialogue and communication between interested scientists. Thus, the purpose of a scientific poster is to communicate your research results at a scientific meeting/conference in which you will not have a chance to give oral presentations.

Each national and international meeting organizer provides instructions or rules governing the preparation of posters for a poster session. So, the actual preparation of the poster should be started after reading the instructions and requirements specified by the meeting organizers. In general, however, poster needs to be concise, simple, clear, legible and visually attractive (eye-catching) in addition to being well constructed and self-explanatory. It must also be created in such a way to focus on issues that are most relevant to the target audience. Remember that, in order to give poster presentations at a suitable scientific meeting (conference, seminars and workshops, project planning and donor meetings), abstract must be submitted and accepted for presentation as a poster at the conference. Thus,

your abstract must conform to abstract guidelines specified by the conference organizers in order for your work to be accepted for presentation.

4.5.1. The key point of a Poster Design

Color and background

Background color for the poster board that contrasts with the color of the paper used for the text often works well, e.g. a dark blue poster board with text printed on white paper. Your poster should be eye-catching; it should draw people towards it by using color combinations that are pleasing to the eye. Avoid fill patterns.

Text

The poster should be legible from a distance of a meter or more away –so keep the text size large (minimum 24 point font). This is to prevent overloading of information that can discourage the interested audience. Use upper and lower case for general content as the use of all-capital text is difficult to read. Also keep the text formatting consistent throughout (i.e. use the same font and colors for the main text, titles of individual sections, etc.). Generally, the text should be used to enhance and support graphical illustrations;

Illustrations

The variety of illustrations can be used for data presentation at poster display includes graphs, photographs, paintings, tables. It is generally recommended that the graphics and photographs are better for poster presentation than tables. If tables must be used, they should not include too many details. All non-essential information should be removed so that no more than four columns and four data are presented on each of them. Graphics should be simple with a maximum of three lines; symbols should be replaced with direct labeling of lines or bars. Bold data lines should be used, and confusing patterns and open bars should be avoided. Each illustration should

have a title. It should be clear, visible and readable. Legends, if any, should be very short. The poster should contain highlights which will enable viewers to easily discern whether the poster is something of interest to them, i.e., the highlights of the several threads well enough give informed viewers the chance to recognize what is going on. If they are interested in the details, there will be plenty of time for asking the questions.

Layout of sections

Posters can adopt a variety of layouts depending on the type of results presented. The nicely laid out board presents the research results in a logical way and serve as a prop for presenters to illustrate what they have done.

- Arrange the board in such a way that it should help you to present your project logically and serve as a prop for you to illustrate what you have done.
- Keep column alignments logical or provide clear cues to your readers how they should "travel" through your poster elements.
- Make your poster visually stimulating - Remember that people who are looking at your poster may have seen many more that day and this will help them remember your work.
- Keep it simple and easy for the audience to read what you have done. Neatness, completeness, and clarity are very important.
- Read the rules that govern what can and cannot be exhibited before you begin.
- Always make sure that your poster conforms to the board size specified by the conference organizers.
- It should be organized for vertical flow of information (Figure 2) so that individuals can view the entire poster in one left-to-right pass.

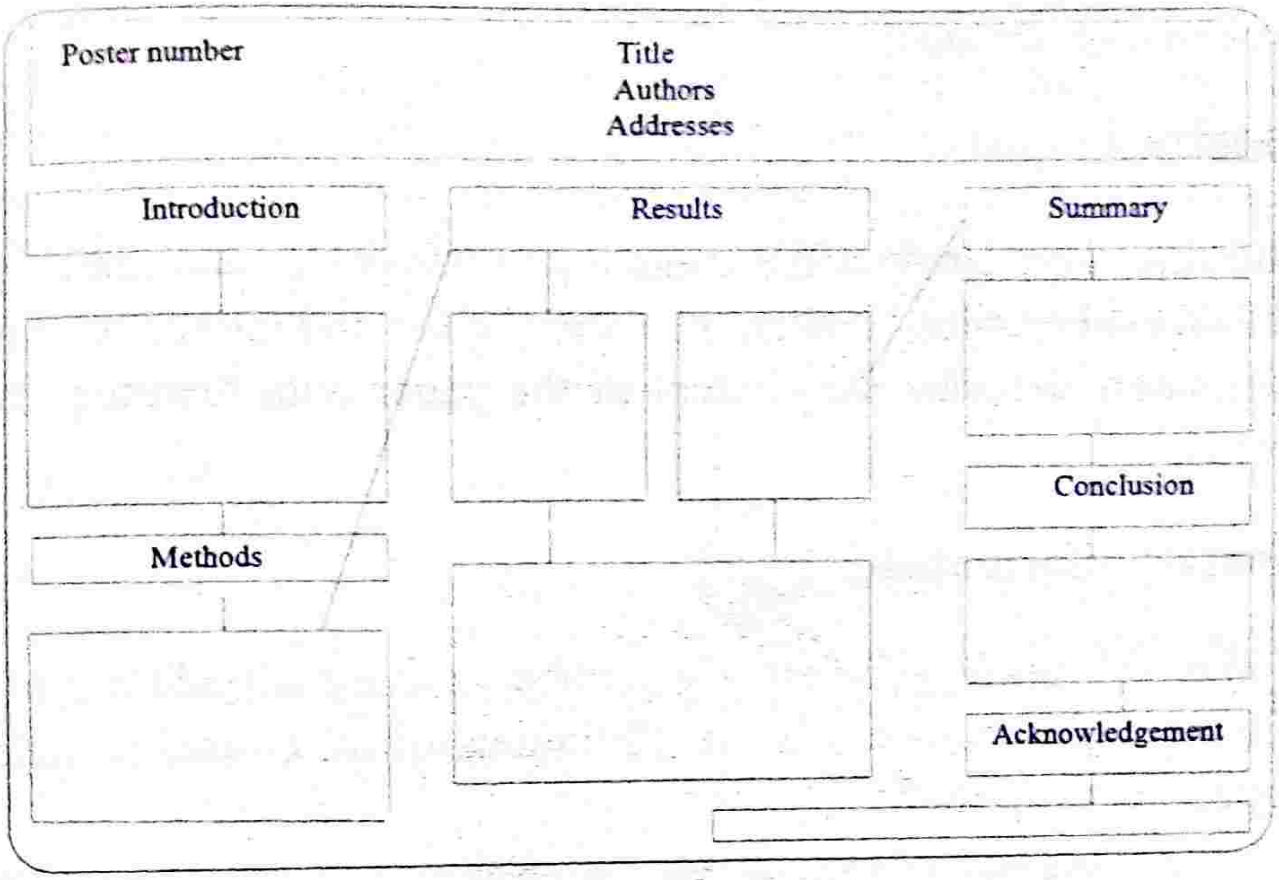

Figure 2: Possible layout or format for Posters

4.5.2. Structure of a Poster

Since a poster presents your work to an audience who is walking through a hallway or exhibit, it should be suited to attract an audience that is passing by, standing and distracted by noise and movement of other people. Thus, the poster organization should follow the IMRAD format in order to attract potential readers in which they have a limited amount of time and patience to look at a poster. This means that the introduction should present the problem concisely; a clear statement of purpose right at the beginning will be enough to describe the type of the approach used.

The methods section must be brief; no detailed description of methods is needed. The results are an essential part of a well-designed poster; most of the available space should be used to illustrate results. The discussion or conclusions should be brief and concise and might be finished by conclusions in the form of numbered short sentences. The literature citation should be minimal and limited to 2-3 essential

references only. The major components of an effective poster presentation include:

Title

The title should reflect the content of your poster and match your abstract submission. It should be short, clear and attractive; it must adequately describe the content of the paper with fewest possible words.

Contact information

Name, organization, telephone number, the e-mail address of the corresponding author and the affiliations of all co-authors should appear on the poster.

Introduction

In the introductory section, describe what you are studying, what is known about it, why it is important (the objectives of your work), what your approach is to investigate the problem, and how your analysis will add to the existing literature in the field. Use short sentences and keep this section as concise as possible. Consider if complete sentences might be replaced by a bulleted list or by a graphic.

Methods

In the data and methods section of statistical analysis, list when, where, who, and how the data were collected, how many cases were involved, and how the data were analyzed.

For other types of interventions or program evaluations, list who, when, where, and how many, along with how the project was implemented and assessed.

Results

In the results section, present what you found. Select the most pertinent results that support your message. Remove everything that is not absolutely necessary. Think about attractive ways to present the data in figures. Try to avoid tables as much as possible. Figures and captions should be easy to read. Consider adding a brief conclusion below every figure.

Conclusion

State the conclusions in short, clear statements, preferably as a list or if you can, try to do this graphically (as in a model summarizing your findings). Finish with an assessment of what you have achieved in relation to your objectives, and, perhaps, your future plans.

References/ Acknowledgments/ further information

It can be added if needed (in smaller font). If your work has already been published make sure to reference it correctly. Even if the poster was created before the work was published and you are presenting it after publication, add a sticker with the new reference on it.

General advice for people presenting posters for the first time

- The information contained in your poster should be clear and understandable without additional verbal explanation.
- Be clear and concise, especially when describing your methods
- Have your poster professionally printed.
- Handouts can be very useful and may be provided in a pouch attached to your poster. You will not be able to leave handouts at the registration desk or on the floor near your poster.
- Generally, delegates will decide whether to read your

poster based on their assessment of your title. If your title appeals to them, they will then look to your introduction and conclusion. Therefore those panels need to be simple, concise and visually attractive.

- Present your information in visual form. Present results in graph form where possible. Use pictures, symbols, and color to assist readers in gaining an understanding of your poster quickly and easily.
- Avoid large tables of data.
- You must include legends and headings for figures and graphs. They should be short but informative.
- We recommend that graphs be no smaller than 12 centimeters by 18 centimeters.
- Photographs should be no smaller than 12 centimeters by 18 centimeters.
- Posters should be used to attract an audience for discussion, not to present complex details of methods and results.
- Number each panel of your poster so sequence for viewing is clear to the viewer.
- Be sure the connection of ideas and the progression of thought is clear from one panel of the poster to another.
- Use a minimum of text (a rule of thumb is that total length of text for a poster presentation should not exceed 25 lines).
- Use lists or phrases instead of complete sentences when possible.
- If an accompanying handout is needed for your poster presentation, label it clearly with the title of your presentation.

Unit Summary

- Written, oral and poster presentations are the major ways in which researchers can communicate their research results and findings to the scientific community.

- Written reporting is the main and most permanent method for communicating research results and findings and writing journal articles may be considered the primary form of such communication.

- The written reports follow particular guidelines depending on the readers or audience. For academic thesis and dissertations, there are guidelines usually in chapters that the report would comply with. For articles to be published in journals, the guidelines are also provided. For reports that have to be presented at conferences, the guidelines are given and the researcher adheres strictly to those for the work to be accepted.

- Research reports should be written in simple and clear language.

- There are many types of scientific publication; research journals, conference proceedings, reports, newsletters, Web pages, etc. Research journals are the most common way of communicating in science.

- The structure of a research article usually depends on the journal to which the article is being submitted. Generally, the standard format has the following components; Title, Abstract, Introduction, Materials and Methods, Results, Discussions, Conclusions, References, Acknowledgments, Annexes (Acknowledgement and appendices are optional, as are tables and figures).

- Giving oral presentations at a suitable scientific meeting (conference, seminars and workshops, project planning and donor meetings) is one way of disseminating research results. It is the most common way to communicate your results to others (peers, decision-makers, administrators, donors, or other stakeholders, the general public), and to obtain the criticism that will improve both your research and subsequent paper(s).

- Oral presentations should be prepared according to the general rules and specific requirements of the organizers of the meeting. The preparation consists of three main items: a selection of material to be presented, organization of the presentation, and preparation for the question-answer section.

- A poster is another way of communication at scientific meetings. By definition, posters are display boards in which scientists show their data and describe their experiments and they are often used to present preliminary findings. As poster sessions became normal parts of many scientific meetings, the preparations of posters should follow particular guidelines, instructions, and requirements specified by the meeting organizers.

- A poster is often structured like other published scientific paper and It must have all parts of a scientific paper, i.e., the organization of poster should follow the IMRAD format.

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1.8. Unit Exercise

1. What is scientific communication?
   a) It is the way how researchers who discover the wonders of science must tell someone about their findings in clear, complete, and concise terms.
   b) It is a step in scientific methods to conduct an experiment.
   c) It is a way to conduct a laboratory experiment.
   d) It is one type of data collection methods.
   e) All of the above.

2. Which of the following statements is correct?
   a) Methods section tells us about how the data were accumulated.
   b) Results section tells us about what data were accumulated.
   c) Results section entails data presentation.
   d) Discussions entail data interpretation.
   e) All of the above.

3. Which of the following options is the purpose of a discussion section?
   a) To summarize the findings presented in the results section
   b) To explain discrepancies between your findings and previous reports.
   c) Point out shortcomings of your work and define unsettled points.
   d) To discuss theoretical and practical implications of your work.
   e) All of the above.

4. Which of the following statements describes the purpose of a Title?

   a) To indicate the subject of your research.

   b) To distinguish your research from others of its kind.

   c) To show continuity with preceding papers.

   d) To provide keywords for indexing.

   e) All of the above.

5. Often, one of the best places to start reading an article to know its content briefly is:

   a) At the end in the discussion section

   b) In the materials and methods section

   c) In the abstract section

   d) In the reference section

   e) All of the above.

6. Which one of the following is incorrect?

   a) The introduction part of a paper should be brief and must state clearly the question that you tried to answer in the study.

   b) The person who did the work and wrote the paper is generally listed as the first author.

   c) Abstracts may also be published separately in bibliographical sources, such as chemical abstracts.

   d) Sometimes a title of an article summarizes the results.

   e) All of the above.

7. Which one of the following is **false** about poster presentation?

a) A poster should be legible from a distance.

b) Materials and methods should be described in short.

c) It is appropriate to use figures and tables instead of text.

d) The introduction should be in the detail.

e) The discussion should be brief.

8. One of the following is true about an oral presentation.

a) Identify the level of knowledge of your audience before your preparation

b) Spoken words must provide a logical transition from one slide to the next.

c) Keep eye contact with your listeners during an oral presentation.

d) Monotone delivery put people to sleep.

e) All of the above.

9. Which one of the following is not a characteristic of a good presentation?

a) Being positive and confident of the work being presented

b) Keeping eye contact with the listener during presentation

c) Practicing ahead of time in front of friends before presentation

d) Try to read directly from PowerPoint during presentation

e) Dressing appropriately and neatly during presentation

10. Which of the following is not a characteristic of a good poster?

a) Presence of clear and understandable information in the poster

b) Use of complete sentence to describe research results

c) Presenting the findings of a research in visual from

d) Presence of clear idea of flow as one moves from one panel of the poster to another

e) Presence of clear and concise method section

UNIT FIVE

ETHICS OF RESEARCH

5.1. Introduction to Ethics in Research

Scientific research is the systematic and rigorous process of inquiry which aims to find answers to questions or problems and/or exploring phenomena and to develop and test explanatory concepts and theories. Research can also be defined as an undertaking intended to extend knowledge through a disciplined inquiry or systematic investigation. Thus, researchers' commitment to the advancement of knowledge also implies duties of honest and thoughtful inquiry, rigorous analysis, commitment to the dissemination of research results, and adherence to the use of professional standards. In addition, ethical research practice plays an important role in advancing the pursuit of knowledge while protecting and respecting research participants and others.

Ethical research practice provides a positively oriented set of practical suggestions for preserving research integrity and pursuing research misconduct. It also leads to better scientific results because the adherence to ethical research practices leads to more attention to the details of scientific research. Also, the credibility of science with the general public depends on the maintenance of the highest ethical standards in research.

Ethical research practice involves the application of fundamental ethical principles and guidelines to a variety of issues involving human subjects or laboratory animals, which helps to promote research integrity and attempt to prevent scientific misconduct. It will also help researchers to satisfy a scientific moral code and to avoid scientific misconducts such as fabrication, falsification, plagiarism, etc., during proposing, performing, or reviewing research, or reporting research results. In this unit, we will discuss some of the general ethical principles recognized in scientific research, as well

as ethical issues involving human subjects or laboratory animals. In addition, we will briefly review fabrication, falsification, and plagiarism which are serious scientific misconducts.

5.2. Unit Objectives

At the end of this unit, you should be able to:

- Define and provide a brief overview of research ethics
- Explain the principles of ethics applicable to scientific research
- Outline the general ethical principles governing research on human subjects.
- Define informed consent
- List and explain the criteria of valid informed consent
- Explain the moral significance of obtaining valid consent
- Explain the following scientific misconducts: falsification, fabrication, and plagiarism.

5.3. Definition and Overview of Research Ethics

Ethics is about the principles and rules we use to decide which actions are acceptable and which are not, and to guide our relationships with others. Ethics is based on what is good, right, fair and just. Research ethics is about the principles and rules we use to decide what is acceptable or ethical when doing scientific research and reporting research results. They ensure that:

- Subjects are protected, and their rights to privacy and confidentiality assured, as well as their voluntary participation in research.

- To promote collaborative work
- Accountability of researchers
- To build public support for research
- Promote moral and social values, such as social responsibility, human rights, and animal welfare, compliance with the law and health and safety.

What are research ethics?

The principle that underpins ethical research is the view that research is not just a matter of collecting information, but is concerned with the dignity, rights, safety and well-being of those who take part in the research. Researchers and others involved in planning and undertaking research should, therefore, ensure that this principle is central to the different elements in the research process.

Research ethics involve a consideration of the conduct of researchers in relation to their own personal behavior as well as how they relate to and treat others during their research. They are about identifying certain norms and standards of behavior that researchers are expected to follow. Research ethics are therefore not about the particular methods that researchers use and whether or not these are the most suitable or appropriate to elicit the information required. They are also not generally about the validity or reliability of the data collected or the accuracy or otherwise of how the data have been interpreted. It involves the application of fundamental ethical principles/rules at each stage of the research process to provide a positively oriented set of practical suggestions for maintaining integrity in research. It also leads to better scientific results because the adherence to ethical research practices leads to more attention to the details of scientific research. Also, the credibility of science with the general public depends on the maintenance of the highest ethical

standards in research.

Many professional bodies and some organizations have established standards, guidelines, policies, and procedures relating to research ethics. They utilize research ethics committees which scrutinize research proposals to ensure that the research being suggested conforms to recognized standards of ethical practice. However, it is important to recognize that it is not possible to develop a comprehensive set of ethical guidelines that deal with each and every eventuality. Rather, the discussion that follows below concerning the general ethical principles should be regarded as indicative rather than exhaustive. It is expected that researchers take time to understand the spirit that underlies each of the principles so that they can translate and apply it to their own particular circumstances prior to initiating a research study.

Activity 5.1

a) Define research ethics and list its importance.

b) List the general ethical principles that guide scientific research.

c) List common ethical principles that have been cited when undertaking research involving humans.

5.4. General Ethical Principles that Guide Scientific Research

Honesty

Researchers should be honest to report their research comprehensively and accurately, including the methods they have used and the data they have gathered. They must avoid selectively reporting their findings or fabricating, falsifying or misrepresenting their findings in any other way. Thus, there is a clear and obvious responsibility upon researchers to report their findings accurately and comprehensively.

Objectivity

Researchers should be committed to the unbiased and objective pursuit of knowledge. They should avoid bias in experimental design, data analysis, and interpretation, conclusions, and recommendations, etc., where objectivity is expected. Commercial affiliations or financial interests at the time of proposing and reporting the research must be disclosed.

Integrity

Researchers conduct themselves in a professional manner characterized by openness, honesty, and objectivity. They should relate the conclusions and recommendations clearly to the key findings of the research to maintain the integrity of the research and avoid concerns about bias.

Carefulness

Researchers should interpret carefully the findings of their research, clearly report any potential limitations that may relate to these and only make claims or propose recommendations that are adequately supported by the data. They should be careful not to make generalizations about the population as a whole, or particular groups within it, from small, unrepresentative case studies.

Openness

Researchers should be open about the methods and procedures they have used and provided adequate information about these so that the quality and validity of their work can be properly assessed by others. They should be open to criticism and new ideas and behave in a professional manner at all times.

Respect for Intellectual property rights

Intellectual property rights are the rights of a creator to control the works he or she has created. Researchers should honor patents, copyright, and other forms of intellectual property. They must give

proper credit for others work or public domain works. They should always acknowledge the contributions of others and the source of their ideas.

Confidentiality

Researchers should make every effort to protect confidential communications such as papers or grants submitted for publication, personal records, trade or military secrets, and research participants records. They should also try to anticipate circumstances where this may be threatened and to make arrangements to address this accordingly.

Responsible publication

Researchers have an obligation to disseminate research results, whether positive or negative, in a timely and competent manner. They should avoid withholding findings, changing or tone down the content of a report. Researchers should publish all results that have scientific merit. They should make research findings accessible to the participants and other interested members of the communities in which the study was conducted. Researchers should not publish the same article in two different places without very good reason to do so.

They should also not divide a research paper that is a self-contained integral whole into a number of smaller papers merely for the sake of expanding the number of items in their bibliography.

Social responsibility

Researchers should be aware of their professional and scientific responsibilities to the community and the society in which they work and live. They should apply their knowledge to promote social good and prevent social harms through research in order to contribute to human welfare.

Researchers should avoid discrimination against subjects on the basis of race, age, sex, disability, education, religious beliefs, ethnic or social origin, language, etc., which are inappropriate or unjustifiable. The selection, recruitment, exclusion, and inclusion of research participants must be just and fair, based on sound scientific and ethical principles.

Competence

Researchers should recognize the boundaries of their own professional competence both in terms of their ability to use particular research methods as well as their substantive academic knowledge of the subject in hand. It is equally important that researchers are appropriately acquainted with the subject they are studying before they commence their research. At the very least, this will help to avoid unnecessary repetition of work that may already exist. The key point here is that researchers identify explicitly the specific knowledge and skills required to undertake the proposed research and ensure that they have these.

Respect for law and public interest

Researchers should engage in due diligence to identify laws, regulations, contracts, and other private agreements that are applicable to their research, and should design and implement research that respects these restrictions. Respect for public interest can often be addressed by obeying relevant laws and researchers should be prepared to accept responsibility for their actions and consequences. Transparency is a mechanism to assess and implement accountability, which itself is necessary to ensure that researchers behave responsibly. These applications interact to ultimately build up trust and good relationships between researchers and particular groups and communities.

Animal care

Researchers should follow appropriate procedures prior to the initiation of any research that requires the use of animals so as to minimize animal pain, suffering, and distress. They should not use more animals than absolutely necessary.

Human subjects' protection

Researchers should respect for the dignity, safety, and well-being of participants involving human subjects. They must obtain Informed consent from potential subjects before participating in the research study. Subjects must be informed of any information regarding the risks and benefits of study participation in an accurate and intelligible manner.

5.5. Principles of Ethics Applicable to Research with Human Subjects

In undertaking research involving humans, certain ethical principles are used as a framework to guide the researcher through the research process and its subsequent use. These principles help to ensure the protection of the rights of all those involved in the research. The ethical principles that have been identified/cited when discussing ethical concerns in human subject's research include respect for persons/autonomy, beneficence, non-maleficence, justice/fairness, veracity, fidelity and confidentiality

5.5.1. Respect for Persons/Autonomy

Respect for autonomy considers the individual as an independent person who is able to make choices for him/herself (Rogero-Anaya 1994). Within the research context, the researcher is required to make certain that the principle of autonomy is adhered to for those participating in research by ensuring:

- The right to self-determination, which means that a person has the right to choose whether or not to participate in a research study

- The right to full disclosure, ensuring that a person has receive information outlining the nature of the study, including th likely risks and benefits, allowing them to make an informe choice

- The participant has the right to withdraw at any time with nc consequences.

The right to self-determination and the right to full disclosure are major components on which informed consent is based (Burns and Grove, 1999, Polit and Beck, 2004). For some groups in society, it may not always be possible to assure the principle of respect for autonomy (O'Neill, 1977). Some may have diminished levels of autonomy and need additional protection regarding participation in research studies, because of their inability to give true informed consent.

5.5.2. Beneficence and Non-maleficence

Beneficence means "to do well" and positively help a person, and non-maleficence means "to do no harm". Research should benefit both individual participants and society as a whole (Parahoo 1997). Participants have the right not to be harmed. Researchers have an ethical duty to balance potential benefits against potential risks and to minimize potential risk to the greatest extent possible, thus safeguarding and protecting participants.

5.5.3. Justice

The principle of justice is synonymous with fairness and equity and researchers are obliged to treat participants fairly and equitably before, during and after the research study. Fairness entails treating all participants with equal respect and concern. Equity requires distributing the benefits and burdens of research participation in such a way that no segment of the population is unduly burdened by the harms of research or denied the benefits of the knowledge generated from it.

5.5.4. Veracity

Veracity involves the concepts of truth about the research study and the absence of deception. Individuals have the right to be told the truth and not to be deceived about any aspect of the research. All aspects of a research project require explanation by the researcher, who must make every effort to ensure the participants understand the implications throughout the study. The principle of veracity is linked with respect for autonomy (Gillon, 1994).

5.5.5. Fidelity

Fidelity means keeping our promises and avoiding negligence with information. It involves the concept of trust (ICN, 1996). Participants place trust in researchers and this necessitates a commitment to protect them. The researcher must ensure that the participants have an understanding of the risks, and thus foster a trusting relationship.

5.5.6. Confidentiality

The researcher is responsible for ensuring the confidentiality and privacy of the research participants and the data obtained from them. Personal information obtained by the researcher must not lead to the identification of research participants and this information should not be made available to others without their consent. Personal information obtained through group research needs attention from both the researcher and research participants to maintain confidentiality. Researchers can ensure that confidentiality is maintained by assigning an identification number to each participant, so that identifying information is effectively secured and that identifying information is not entered on a computer system or other potentially accessible database (Polit and Beck, 2004).

5.5.7. Informed Consent

The principle of informed consent refers to the individual's right to decide whether they wish to participate in a specific research project. All research projects should be based on the freely given

and informed consent of potential participants. Informed consent means that a participant has been informed about the risks and benefits of the research, understands such risks and benefits and is able to give consent to participation, without coercion, undue influence or inappropriate incentives. Thus, the purpose of informed consent is to protect research participants and allow them to make informed choices. Obtaining written informed consent to participate in research is one of the most important ethical considerations in the research process and it ensures that the principle of "respect for persons" is acknowledged and adhered to. Consent to participate in research should never be presumed. The following essential elements are required for a valid informed consent

- Disclosure of information
- Comprehension
- Competency
- Voluntariness

Disclosure of information

Participants must be fully informed of all aspects and proceedings of the research project, including the risks, benefits and the right to withdraw from the project at any time. The information provided must be sufficient, and communicated accurately in an understandable way and using appropriate language or mechanisms. With regard to the comprehension of information, the participant should be given time to consider the proposed research so that individuals have the opportunity to ask questions or to have explanations repeated. The opportunity for participants to ask questions about the proposed research on a continuous basis is also required.

Disclosure includes:

- The aims of the research
- The research methods to be employed

- The expected risks and benefits to the participant/society
- Assurances of confidentiality
- Details of the funding body (if any)
- Any possible risks, stresses, discomforts or inconvenience or unpleasant that might be involved
- A statement that the participant can withdraw from the study at any time without prejudice

The informed consent document must also disclose what compensation and medical treatment are available in the case of a research-related injury. The document should also make it clear whom to contact in case of injury.

Comprehension

The researcher must ensure that every effort has been made to ensure the participant understands the information disclosed. The information disclosed must be presented in very simple language and translated into other languages spoken in the community (if applicable). Researchers will also need to consider that potential participant only agrees to take part after fully understanding what is involved.

Competence

If a participant is to make a decision regarding participation in research, he/she must be competent to understand and be able to come to a decision about what is involved. If a participant may not be competent or able to give informed consent, an appropriate person to make the choice for them must be identified by the investigator. In the case of children (individuals under 16 years of age), no research shall be conducted without a specified means of gaining their informed consent (or, in the case of young children, their assent) and the consent of their parents or guardians.

Voluntariness

Consent to participate must be given voluntarily and is only valid if given without intimidation, coercion, persuasion, manipulation or inducement. The researcher must ensure the right of each participant to determine his or her voluntary participation in research. Written informed consent is required for all research. The consent form should provide a written explanation about the research study, including the purpose of the study, study design, sampling procedure, and potential benefits and risks and voluntary nature of the study. A consent form is signed and dated by the research participant and the researcher. Where research involves the use of questionnaires, completion of the questionnaire implies consent is being given. This is appropriate, as it contains all the elements of informed consent. In institutional settings (prisons, child protection institutions, hospitals, homes for the elderly, etc.) it is important to make sure that consent is given voluntarily by each and every subject. If research intervenes in the physical integrity of subjects, consent must always be given in writing or in some other certifiable way, unless this is contrary to the interests of subjects. Participants should be informed clearly that they have a right to withdraw their consent at any time, that any data that they have provided will be destroyed if they so request and that there will be no resultant adverse consequences.

Activity 5.2

a. Define valid informed consent and list its essential elements.

b. List common scientific misconducts.

5.6. Scientific Misconduct

What is scientific misconduct/fraud?

Scientific misconduct is fabrication, falsification or plagiarism in the conduct of research and the dissemination of its results. The

5.6.1. Fabrication and Falsification

Both fabrication (an invention of data) and falsification (altering data or tampering with the experimental procedure) have the same effect: misrepresentation of research results. Both of these schemes are dangerous to research because they alter the reliability of data that may be used in systems that are sometimes vital to life putting thousands of lives in danger and sometimes death. Fabrication and falsification of research data diminish the status of the research and may create a dangerous situation for those who use such data and they are considered as the most serious forms of misconduct. It is a primary responsibility of a researcher to avoid either a false statement or an omission that distorts the research record.

5.6.2. Plagiarism

Plagiarism is using someone else's work without giving credit. It is considered scientific misconduct or academic dishonesty or an act of lying, cheating, and stealing other people's work and intellectual property without their consent. Simply put, plagiarism is the theft of intellectual property belonging to another. This includes both the theft of unwritten ideas and concepts as well as the theft of written texts, notes, computer programs, designs, and/or visual materials.

Examples of plagiarism include using others' ideas, thoughts, or without citing them; paraphrasing or summarizing other people's work without citing it; copying images or text from the Web without proper acknowledgment, or borrowing facts or statistics that are not common knowledge without proper acknowledgment. Specifically, plagiarism can take the following forms but is not limited to the following situations:

- Paraphrasing, translating, or summarizing someone else's ideas without acknowledgment;
- Presentation of someone else's ideas without acknowledgment;
- Verbatim repetition of someone else's words without acknowledgment;

- Improper acknowledgment of sources, as with incomplete or imprecise documentation,
- Patch writing: using words and phrases from a source text (that may or may not have been acknowledged) and patching them together in new sentences
- Failure to cite: not acknowledging the sources of words or information
- Failure to quote: not providing quotation marks for direct quotation
- Having one's work done by someone else ('ghostwriting') or having one's work substantially revised by someone else
- Self-plagiarism: reuse your own paper or modify a paper you have already written or unexplained duplication of publication without citation
- Salami Slicing (data fragmentation): the segmenting of a large study into two or more publications
- Redundant publication: submitting the same manuscript to be under review by more than one journal at the same time or Submitting identical or similar work in more than one publication
- Copyright Infringement: extensive paraphrasing or quoting of key elements or text from a copyrighted source
- Ghost Authorship: -a written work fails to identify individuals who made significant contributions to the research and writing of that work.
- Misuse of privileged information: use of the original idea taken from a grant application or manuscript received from a funding agency or journal editor for peer review.

Plagiarism, where the work of another is misappropriated, inflicts damage on the proper attribution of credit. This is severely harmful

because credit and authorship motivate a great part of the research, and have legal implications within intellectual property law. Plagiarism diminishes the value of the works and tarnishes the integrity and ethics of the author.

Avoiding plagiarism

Plagiarism is a very serious offense. However, there are several techniques you can use to avoid plagiarism in your writing. These include quoting, paraphrasing, and summarizing. To quote a source correctly, copy the passage word for word, place those words in quotation marks, and cite the source in which you found the quote. The second approach is to paraphrase the passage. To paraphrase, you simply restate the information from a source using your own words. A paraphrased passage will be about the same length as the original passage and does not need quotes. However, you must cite the source. The third approach is to summarize a passage. A summarized passage includes only the main ideas of a source in your own words, leaving out specific details. Summaries are shorter than paraphrased passages. They are simply a brief distillation of the writer's ideas. You do not need to use quotes, but the summarized passage must still be cited.

5.7. Unit Summary

- Ethics of scientific research concerns the application of ethical rules of what is right and wrong in research.
- There are general principles that are of importance in the ethics of research- Honesty, objectivity, integrity, Confidentiality, Respect for Intellectual property rights, Respect for law and public interest, etc.
- The protection of the human rights of subjects in research include the concepts of consent and honesty; beneficence (doing good and avoiding harm); and justice (fairness to all subjects irrespective of status, race or ethnic origin), confidentiality and privacy, etc.
- Permissions should always be sought for research that involves human subjects in whatever settings.
- Research misconduct is defined as fabrication, falsification, or plagiarism, including misrepresentation of credentials, in proposing, performing, or reviewing research, or in reporting research results.

5.8. Reference/Further readings

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5.9. Unit Exercise

1. Which one of the following is a general ethical principle applicable to research?
   a) Honesty and objectivity
   b) Integrity and Confidentiality
   c) Respect for Intellectual property rights
   d) Respect for law and public interest
   e) All of the above.

2. Which one of the following is the main ethical issue in human-related research?
   a) The safety of the research participant
   b) Obtaining informed permission from each participant
   c) Enumerating hoe privacy and confidentiality concerns will be approached
   d) Considering how adverse events will be handled
   e) All of the above.

3. Which one of the following is the essential element of a valid informed consent?
   a) Disclosure of information
   b) Comprehension
   c) Competency
   d) Voluntariness
   e) All of the above.

4. Which one of the following is considered as data falsification?
   a) Discarding data during sampling without any reason
   b) Discarding data during analysis without any clear criteria
   c) Leaving out an "inconvenient" observation with no comment and justification
   d) A and B only.
   e) All of the above.

Which one of the following acts is considered as plagiarism?

a) Reporting someone else's work as if it were your own
b) Copying someone else's work
c) Getting someone else to do your work for you
d) A and B only.
e) All of the above.

Appendix-II Sample work schedule in an M.Sc. project

Activity	Person(s) responsible	Time period	Dates (from X until Y)
Finding and reading previous literature	P.I.	3 weeks	1 October -21 October
Designing methods and data collection tools	P.I.	2 weeks	22 October – 6 November
Refine proposal	P.I. and Advisor	1 week	7 November- 15 November
Sample preparation, analysis and data collection	P.I. and R.A.	4 weeks	16 November 15 December
Data analysis	P.I.	2 weeks	16 December -1 January
Writing up	P.I.	2 weeks	2 January -17 January
Proof read	P.I. and Advisor	1 week	18 January -1 February
Rewriting	P.I.	1 week	2 February - 10 February
Disseminating findings	P.I. and Advisor	2 weeks	15 February – 30 February

Here, P.I. = principal investigator; R.A. = research assistant

Appendix-III Sample Gantt chart in M.Sc. project

Activity	Person(s) responsible	Month 1	Month 2	Month 3	Month 4	Month 5
Finding and reading previous literature	P.I.					
Designing methods and data collection tools	P.I.					
Refine proposal	P.I. and Advisor					
Sample preparation, analysis and data collection	P.I. and R.A.					
Data analysis	P.I.					
Writing up	P.I.					
Proof read	P.I. and Advisor					
Rewriting	P.I.					
Disseminating findings	P.I. and Advisor					

Where, P.I. = principal investigator; R.A. = research assistant

Answer Key for Activities

tivity 1.1 answers

a. It is a global archive of scientific knowledge. It is the principal medium for communicating the results of scientific research or achievements of the scientific community over time.

b. Primary scientific literature: publications that report the results of original scientific research. These include the journal, technical reports, conference proceedings, patents, dissertations (Ph. D thesis), theses (masters), monographic series, and grant reports. Secondary scientific literature: publications that synthesize and condense what is known on specific topics. These include review articles, indexing, and abstracting journals, textbooks, manuals, treaties and monographs, handbooks, dictionaries, and encyclopedias. Tertiary scientific literature: publications that are based on primary or secondary scientific literature sources. These include chemical catalogs (Aldrich, Lancaster, etc.,), guides, and material safety data sheets (MSDS).

tivity 1.2 answers

a. It is a periodical, especially the one containing scholarly articles and /or disseminating current information on research and development in a particular subject area.

b. It facilitates the dissemination of scientific work to as wide an audience as possible. It also offers readers an aggregated collection of current research in the field of interest, raising awareness of new techniques, and also helps to prevent duplication of experiments.

c. Full-length research article consists of sections such as Bibliographic information (article title, authors, author addresses), Abstract (include keywords), introduction, Materials and Methods, Results and discussions, Conclusions and Recommendations, references, and Acknowledgments.

Letters and Communications consist of sections such as introduction, combined results/discussion, and no materials and methods sections. Review articles consist of sections such as introduction, a body of the paper, conclusion and future directions and literature cited (reference).

Activity 1.3 answers

a. It is a lengthier and more rigorous process by which articles submitted to a journal are evaluated by experts/scientists/professionals in that field to decide whether the submitted articles are accepted/rejected for publication.

b. A conference paper is original contributions that was presented orally or in form of a poster at scientific meetings whereas technical; reports are an outgrowth of an institution (government-funded) research that reports comprehensive results and is ongoing rather than a completed work.

Activity 1.4 answers

a. It includes CD-ROMs and DVD-ROMs databases, on-line databases, e-journals, e-books, e-conference proceedings, Internet search engines, etc.

b. Physical visit to academic libraries and browsing through print information resources or electronic resources; by searching the internet from anywhere with an internet connection

c. It includes credentials of the author, Objectivity, date, source, Concurrency with other sources, etc.

Activity 2.1 answers

a. Science can be defined as a pathway to study phenomena in the natural world, based upon reproducibility, testable and verifiable evidence. The scientific method is considered as a series of steps followed by scientists to answer specific questions/problems about the natural world. It involves making an observation, formulating a hypothesis, and conducting scientific experiments.

Activity 2.2 answers

a. A systematic investigation of a subject matter, problem, or phenomena to add to knowledge, to gain solutions to problems or to discover and interpret new facts and relationships.

b. The general purpose of research in whatever field of study includes describing and explain phenomena/problems/events, predicting phenomena, and ultimately controlling events.

c. Research has the following characteristics. It must be controlled, rigorous, systematic, valid and verifiable, empirical, and critical.

Activity 2.3 answers

a. These are applied and basic research, qualitative and quantitative research, experimental and non-experimental research.

b. Applied research is a study that has been designed to discover a solution for some pressing practical problems. In this type of research, the immediacy of the problem will be more important than academic theorizing. However, basic research conducted primarily to improve our understanding of general issues without emphasis on its immediate application. It is also regarded as the most academic form of research, as the principal aim is to contribute to knowledge.

Activity 3.1 answers

a. Possible sources that usually contribute to problem identification includes one's own experience or the experience of others, scientific literature, and theories.

b. It means narrowing down the general interest in a research topic to focus on a particular research problem or issue that is small enough to be investigated. This leads on to set the research question(s) or find a narrow perspective or focus on the topic by asking a series of questions about the topic.

Activity 3.2 answers

a. It will help to avoid unnecessary duplication of research that has already been published; it will give the researcher to demonstrate his/her familiarity with the relevant works of others and ability to summarize it for the convenience of the readers; it will also help researcher to give readers background information regarding his/her research and show how his/her work has added to knowledge on the subject area.

b. Quotations: an exact copy of the original material. It is set off with quotation marks. Paraphrase: restating the materials you have read in your own words. It reproduces the thought and meaning of the original materials. Summarizing: It reproduces the main idea of the original materials by condensing many pages to a few sentences.

Activity 3.3 answers

a. Research proposal or protocol is a concise written plan of the research you intend to undertake or it is the written plan of action that contains all the key elements involved in a research process aimed at solving a certain problem.

b. The conventional proposal format has the following sections: title and cover page, literature review (background), objectives, materials and methods, work plan, budget plan, and references

Activity 4.1 answers

a. Communicating research findings means sharing the findings of research to different groups or audiences depending on why that research was conducted.

b. Research findings could be communicated through writing a scientific paper (journal articles, conference papers, etc.), oral presentations, and poster presentations.

a. The acronym IMRAD stands for Introduction, Methods, Results, and Discussion. These are sections of scientific publications that contain the main substance of scientific research.

b. The following information is incorporated in the introduction section of a scientific paper: summary of the problem to be investigated, background information on the problem, objectives of the study, significance of the study, review of relevant studies by other researchers, description and justification of methods used, and pointing out gaps in the previous studies about the topic and how the study addresses the gap.

Activity 4.3 answers

a. The result section presents the outcomes of the study without interpreting it. That is, reporting what you found. Whereas the discussion section presents an interpretation of the results and shows how the results have answered the questions set to outline the introduction section.

b. The two types/way of citing sources both in the text of an article and reference list are the Harvard (author-year) system and the Vancouver (numbering) system.

Activity 4.4 answers

a. The major phase of preparing an oral presentation includes the preparation phase (selection of materials to be presented), organization of the presentation (speech) and the question and answer session.

b. Oral presentation at the scientific meetings requires presenting materials (research results) clearly and effectively within the allotted time. Whereas poster presentation is presenting the same materials when you do not have a chance to give oral presentations (lack of time for oral presentation). However,

to give both oral and poster presentations at s scientific meetings, abstracts must be submitted and accepted by the conference organizers and the abstract should follow the IMRAD format.

ctivity 5.1 answers

a. It is the principles and rules used to decide what is acceptable or ethical when doing scientific research and reporting research results. It is important to promote integrity 9collaborative work) and to prevent scientific misconducts such as fabrication, falsification, plagiarism, etc., and to ensure the rights to privacy and confidentiality of subjects/ participants.

b. It includes honesty, objectivity, integrity, carefulness, openness, respect for intellectual property rights, confidentiality, responsible publication, social responsibility, nondiscrimination, competence, respect for law and public interest.

c. The ethical principles that have been identified when discussing ethical concerns in human subject's research include respect for persons/autonomy, beneficence, non-maleficence, justice/fairness, veracity, fidelity and confidentiality

ctivity 5.2 answers

a. It refers to the individual's right to decide whether they wish to participate in a specific research project. Or it is a way of informing a participant about the risks and benefits of the research and can give consent to participation, without coercion, undue influence or inappropriate incentives.

b. Common scientific misconduct in the conduct of research and dissemination of its results includes fabrication and falsification, misrepresentation, failure of informed consent, breaches of confidentiality, plagiarism and its different forms.

Answer for Unit Exercises

Answer For Unit One Exercise

1.	E	3.	D	5.	E	7.	E
2.	E	4.	E	6.	E		

Answer For Unit Two Exercise

1.	D	4.	E	7.	D	10.	A and D
2.	B	5.	B	8.	B		
3.	C	6.	A	9.	C		

Answer For Unit Three Exercise

1.	E	5.	E	9.	D	13.	E
2.	E	6.	E	10.	E	14.	E
3.	E	7.	E	11.	E	15.	D
4.	E	8.	E	12.	E	16.	E

Answer For Unit Four Exercise

1.	A	5.	E	9.	E
2.		6..	C	10.	D
3.	E	7.	D	11.	B
4.	E	8.	E		

Answer For Unit Five Exercise

1.	E	3.	E	5.	E
2.	E	4.	E		