RESEARCH METHODS

(FOR ENGINEERS)

Chief Editor

Dr. Sanjeevreddy K. Hudgikar
Professor and Principal
Lingaraj Appa Engineering College,
Bidar, Karnatak, India.

Kripa Drishti Publications, Pune.

RESEARCH METHODS: FOR ENGINEERS

Chief Editor

Dr. Sanjeevreddy K. Hudgikar
Professor and Principal,
Lingaraj Appa Engineering College,
Bidar, Karnatak, India.

Kripa-Drishti Publications, Pune.

Book Title: **Research Methods: For Engineers**

Editor: **Dr. Sanjeevreddy K. Hudgikar**

Author's by: Prof. Ambalika Sinha, Arnab Chowdhury, Jayanta Mete, Deblina Talukdar, Deepthi Karunakaran, Dr. P. B. Beulahbel Bency, Divya Bharati, Dr. G. P. Dinesh, Dr. Prashantha Kumara T. M., Rimmi Datta, Soumyashree Sarkar, Suneeta Khanna Ganguly, Pooja Kumawat, Chandra Prakash Saini, Dr. Vinod Mandal, Dipen Roy.

4th Edition

ISBN: **978-93-90847-07-5**

9 789390 847075

Published: **February 2021**

Publisher:

KRIPA DRISHTI PUBLICATIONS

Kripa-Drishti Publications

A-503 Poorva Heights, Pashan-Sus Road, Near Sai Chowk,

Pune – 411021, Maharashtra, India.

Mob: +91-8007068686

Email: editor@kdpublications.in

Web: https://www.kdpublications.in

CONTENT

ISBN: 978-93-90847-07-5

Chapter - 1 : Sampling Techniques

Prof. Ambalika Sinha

Director, Shambhunath Institute of Management, Jhalwa, Prayagraj.

1.1 Introduction:

When a researcher conducts research and indulges in data collection for predicting behavior of a population. As it is not possible to collect data on the whole universe a sample which is perceived as the best fit for predicting about the universe is extracted for survey or research data collection and this result is used in predicting about the whole universe.

Sample means the group of individuals who will actually participate in the research for predicting about the universe them represent. To interpret rightly from the sample about the universe the sample should be selected appropriately.

Sampling assists a lot in judging about population. Using sample from the population and doing data collection on it will help us to judge about population in acredible manner. Hence if sample is not selected scientifically than the judgments made about population may be inaccurate. There are many techniques of sampling. But the technique used to select sample depends on the demand of purpose and aim of the research. This chapter tries to present some of those techniques.

To begin with terminologies for various aspects included in sampling are as follows.

1st Population/universe of research: All the parts of the universe are the population who will be studied is the universe of study, e. g Universe of helmet users, out of which a few persons of this category will be researched upon to assess about the universe.

2nd Sample: It is not possible to do research on the whole universe (e.g. Universe, hence a part of the universe will be used, this is the sample.

3rd Sampling: How the sample will be sized up is sampling procedure. Various sampling techniques may be clubbed into two categories:

- Probability Sampling
- Non- Probability Sampling

Difference between Probability Sampling and Non-Probability Sampling Methods:

As Provided by Www.Questionpro.Com/Blogis As Follows:

We have looked at the different types of sampling methods above and their subtypes.

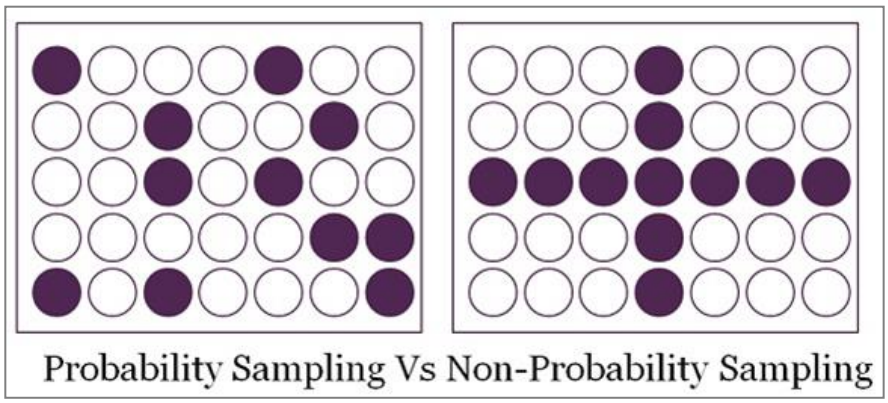
To encapsulate the whole discussion, though, the significant differences between probability sampling methods and non-probability sampling methods are as below:

	Probability Sampling Methods	**Non-Probability Sampling Methods**
Definition	Probability Sampling is a sampling technique in which samples from a larger population are chosen using a method based on the theory of probability.	Non-probability sampling is a sampling technique in which the researcher selects samples based on the researcher's subjective judgment rather than random selection.
Alternatively Known as	Random sampling method.	Non-random sampling method.
Population Selection	The population is selected randomly.	The population is selected arbitrarily.
Nature	The research is conclusive.	The research is exploratory.
Sample	Since there is a method for deciding the sample, the population demographics are conclusively represented.	Since the sampling method is arbitrary, the population demographics representation is almost always skewed.
Time Taken	Takes longer to conduct since the research design defines the selection parameters before the market research study begins.	This type of sampling method is quick since neither the sample or selection criteria of the sample are undefined.
Results	This type of sampling is entirely unbiased and hence the results are unbiased too and conclusive.	This type of sampling is entirely biased and hence the results are biased too, rendering the research speculative.
Hypothesis	In probability sampling, there is an underlying hypothesis before the study begins and the objective of this method is to prove the hypothesis.	In non-probability sampling, the hypothesis is derived after conducting the research study.

An account is given of the various sampling techniques.

1.2 Probability Sampling:

Probability Sampling means that all elements of the universe have equal chance of being considered in the sample. Through randomization. Other term for it is random sampling.

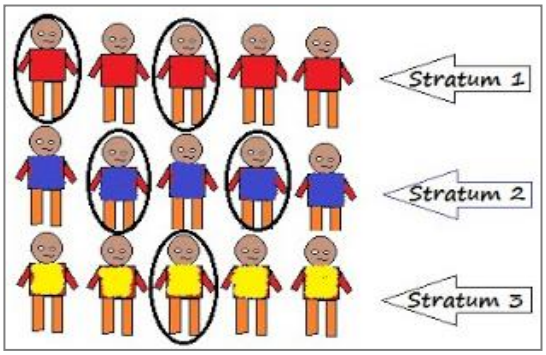


There are following main types of probability sample.

- Simple random sampling.
- Systematic sampling.
- Stratified sampling.
- Cluster sampling.
- Multi-stage sampling
- Area sampling

a. Simple Random Sampling: Every element has an equal chance of getting selected to be the part sample. It is used when we are unaware about the population details. E.g. If helmet users of a city are one lakh people we may do survey on $1/20^{th}$ part of the population may be the sample size.

b. Stratified Sampling: This technique creates strata's of the population based on similarities and. Difference. And then every unit of the strata has a chance of being selected on the random bases the researcher should have awareness about similarities and differences to create stratas. For example in the case of helmet users we can categorize on the basis of male and female two wheeler drivers from various geographical zones of the city and when this data is stratified we may randomly select persons for data collection.



c. **Systematic Sampling:** Systematic sampling method is used by researchers to select sample unit members from the universe at regular interval. A starting point is highlighted from which the sample size will be considered and also it depicts the sample size for a given population. This type of sampling method defines the sample size to be considered, for e.g. 20% of one lakh helmet users is calculated and selected and the period from which the sample should be considered, from which zone make sample selection easy. Another example is a researcher intends to collect a systematic sample of 500 people in a population of 5000. He/she numbers each element of the population from 1-5000 and will choose every 10th individual to be a part of the sample (Total population/ Sample Size = 5000/500 = 10).
d. **Cluster Sampling:** In this method the whole universe is divided into sections called clusters which altogether represent the whole universe. Clusters are identified on the basis of demographic variables like age, sex, location, etc. This makes it easy to select sample from multiple demographic sections and the finding which is ultimately observed may be based on fair distribution. No segment is excluded. For example, if the United States government wishes to evaluate the number of immigrants living in the Mainland US, they can divide it into clusters based on states such as California, Texas, Florida, Massachusetts, Colorado, Hawaii, etc. This way of conducting a survey will be more effective as the results will be organized into states and provide insightful immigration data.
e. **Multi Stage Sampling:** This type of sampling occurs when the next stage is determined on the basis of findings from the first stage. Findings from first stage determine how we will do research in the next stage. It may utilize the combination of various methods of probability sampling which are appropriate for that stage. Normally in multi-stage sampling design is applicable in a big inquires of geographical area, for the entire country. Multistage sampling has to with the combination of the various methods of probability sampling in most effective and efficient approach.
f. **Area Sampling:** Is a design sampling that deals with geographical subdivision of environment that represents clusters of unit's which are part of the universe, for example if SEZ of India are studied than that will be based on terrestrial location.

1.3 Non-Probability Sampling:

In **non-probability sampling**, the sample is selected based on the basis of purpose. Sample units are included based on what one wants to study. All universe cannot be represented in non-probability sample, only those who serve your purpose are included in it.

Non-probability sampling is used for the following:

a. Exploratory research: Researchers use this sampling technique widely when conducting them are in the initial state of their research .and usually do qualitative research, pilot studies, or exploratory research.

b. Making hypotheses: When review is over, modal sampling method may be used for generation various knowledge about their research which may help in selecting the variables to be studied and how dependent and independent variables will be related, hence predictions are made. Economic and time considerations: For preliminary data collection and pilot study one does not want to waste money and time. For surveys and questionnaires strata's have not to be rigidly considered hence they prefer non-probability sampling procedure.

The diverse method of different sampling considering the non-random designs are:

A. Quota sampling,
B. Accidental sampling,
C. Judgmental sampling or Purposive sampling,
D. Expert sampling,
E. Snowball sampling,
F. Modal instant sampling

From the listed the researcher has to deliberately select items to be sample. This type of sampling is costly in application.

1.3.1 Types of Non-Probability Random Sampling:

A. Quota Sampling:

In research, very often it is not feasible to cover the whole universe to be studied because of lack of time, budgetary constraints and social hassles hence researchers selection of sample is at the convenience of researcher. Whatever criteria one wants to study on that bases one selects sample which suits those criteria. He will fix the sample size, persons in the sample will be holding characteristics which he plans to study, and as the number of persons he has planned to include is reached, he will do the analysis on that sample on which data is collected. , his tallying will be at his convenience guided by some evidence of characteristic, such as sex, race, based on population of interest. The sample selection is by the convenient door of the researcher.

Quota sampling is of two types; first is proportionate quota sampling which represent the characteristics of major population by just collecting data from a fraction of the universe which is statistically right for proving about the Universe under study. Example if we are interested in studying population of females getting education we may visit urban vs rural schools to survey education level of girls in both settings. They are equal proportion of the total Quota which are convenient to assess. An equal proportion of school going girls from rural setting schools and some urban setting schools, i.e., 200 from urban and 200 from rural. When the data is collected on this sample we will stop and predict about the universe on the basis of 400 females surveyed from nearby urban and rural settings,

The major setback of Quota sampling is that one uses one criteria for deciding quota, for e.g. education level of girls was the deciding factor, no other factors were considered as significant. The non-proportional quota sampling is a technique which is not interested in matching proportion of sample with quota. It is meaningful if it just gives finding for a small cluster of the quota.

B. Accidental Sampling:

This sampling method is like quota sampling. But often is based on subjective data. It is analysis of reading material, most popular among market analysts and newspaper analysts. They by chance come across matter which they may use for their survey purpose. It has the same advantages and disadvantages as quota sampling.

C. Judgmental or Purposive Sampling:

The sampling design is based on the requirement and purpose of the researcher, he assesses the type of sample that will fit his requirement. The researcher highlights his intention through doing research on the type of sample which will provide him the data which will serve his purpose and respondents are ready to serve him.

D. Expert Sampling:

The researcher discusses with experts in the area in which he is doing research, takes their view and on that basis does data collection on the sample which he feels is appropriate according to experts' opinion. Here seeks for the consent of those that are expert or known expert in the area of study and begin the process of collecting his information directly from individual or group of respondent. It also involves sample collection based on one's specialized knowledge and experience as a researcher and does sample accumulation who according to researcher are suitable. It can also be used to check the credibility of the other sampling techniques used.

E. Snowball Sampling:

The sample design is based on one's network. The researcher many know two or three persons from the organization, on their reference he may add others from the sample organization in his sample. This selection is based completely on communication, it is like a chain, one person linking the researcher with others whom he knows. It is useful when the researcher know little about a group or organization to study. The disadvantage is that the choice of the whole sample balances on the intermittent communicator. He may know persons of a specific type, but he may be biased in this type of selection, as the connecting persons may exclude those who are unknown to him which my deprive the researcher of fair sample.

F, Modal Instant Sampling:

In this type of sampling researcher may use the sample with most frequent representation of the characteristic which is desired to be studied. Persons selected in the sample a have had the experience to be researched upon very frequently, like the typical voter in the public opinion poll, or news readers who highlight an event in the most emphatic way. It can also be a group of persons with the most vivid view about any significant incident like flood calamity reporters or Kedarnath event reporters. There are problems with these types of sampling. may be the persons we select may not match on other demographic variables like age, gender, seniority, religion, etc, this may bring diversity in their narration which may give skewed findings, making it difficult to generalize.

G. Heterogeneity Sampling:

This sampling is sampling by diversity. In it persons with variety of information are tapped. That is their view about the research topic from various angles. This is just the contradictor sampling method as compared to modal instant sampling. All possible views are categorized and then frequency of various views may be assessed. More the ideas coming up about a research topic better it is.

That reveals the variation in perception, beliefs and knowledge about the research. This sampling may suit in the beginning of research when we assess the various views held NY people and then look for common elements which can be further studied.

1.4 Conclusion:

In conclusion the probability random sampling is more preferable because the researcher generate his data for the use of entire population by using probabilistic method to control biased during the sampling, based on evidence generated by the agencies of statistical official that the non-probability techniques is based on purpose that lead to assumption which resulting to risk. Basing on assumption means one will generate inappropriate generalization of the population.[1-20]

ISBN: 978-93-90847-07-5

Chapter - 2 : Essay Writing

Arnab Chowdhury Student (Ex),

School of education, Netaji Subhas Open University, Kolkata, West Bengal, India.

&

Jayanta Mete

Dept. Of education, University of Kalyani, Nadia, West Bengal, India.

2.1 Aims of the Essay:

The following work aims to give resources to students an insight of writing an essay. This itself being an essay will be organized in a similar way an essay should be organized. This is going to provide you with critical information as well as exercises that is going to help the students to learn and write properly in their studies.

This is mainly an academic skill, and this mainly focuses on writing academic essays. Writing skill is what a student needs the most thorough out his/her career. From writing school essays to thesis papers and research papers, writing skill the only skill that is valued at most.

Students do have a wide range of skill, some of them may have a proper set of vocabulary, some may be able to speak in English fluently and even some of them may have really good typing skills. The teacher should use the existing skills of the students and use it to enhance others academic skills such as writing an essay.

This is one such skill that can be learned and transferred from the teacher to the student or from peer to peer. There's a saying, "Give a man a bread and you feed him for a day, teach the man to make a bread, you feed him for life."

The Real-World vs The Academic World: Let us now discuss the difference between the real world and the academic world. In simple terms we can just say that they are not same at all and this is understandable that yes, these two worlds can never be the same. According to Levin (2004) the "Academic world" and the "Real world" are not the same and students need to learn the difference between the worlds. To differentiate let us just go through some of the things that differ at large.

The real world is where we have our experiences and we learn from our experiences, whatever we do work, play, spending time with family and friends. Living along with the nature in our own niche. Whatever we learn from here these all are real world experiences and they help us a lot to build our character and life. Whereas the academic world is filled with theories, logics, explanations and criticism. It is not possible to experience the real world through any kind of literature, what we can do is just imagine those things that the author or the poet has written. We can never experience such a situation until and unless that happens in our daily life. Whatever we learn from here is what someone else has written down and it is what they had experienced in their life.

So, we are experiencing something second hand rather than our own experience. Let us take an example of William Wordsworth's poetry "Composed upon Westminster Bridge", in the poem the poet writes the his experience and feeling that he felt when he was standing on the Westminster Bridge in an early morning during sunrise. When we read that poem the only thing, we can do is to feel what the poet has felt, and we may or may not have such an experience ever. This is something the students must understand about the real world and the academic world. According to Levin (2004, p5) "The culture of higher education in the Western world is very much a culture of the written world."

Let us begin the session with an activity where I am going to outline the rules of writing an essay, where a student can try to understand what they must do to write an essay

2.2 Rules of Writing an Essay:

a. The student must analyze what is being asked in the question. They must be sure of the answer before writing. They should read the question multiple times and if there is any doubt, they can clear it from the teacher or any peer.
b. The language of the essay must be purely academic. Most of the time nowadays students spend time chatting on the internet and they either use short forms such as "YOU" is being written as "U", this type of slang or small talk must be avoided.
c. An essay cannot be about what the writer thinks correct. If the writer thinks that his or her opinion has to be taken into account, then it must be backed by some evidence and that must be hard evidence and not just any fluke. Usually this kind of evidence can be references from the writings of other authors. Where if the author has a copyright, the writer must take permission from the author to use the text as a reference.
d. It sometime depends on the teacher how they expect the students to write and these varies of one teacher to the other. They like to follow a certain rule of academic writing. The student should always consult with the teacher if he or she follows a different approach to writing. Which should be corrected by the teacher. Even though this should be the concern, but academic writings are about getting marks and hence the student must follow the instruction of the teacher on the ways of writing an answer.
e. Just writing a point should not matter. If it something that has been published before and the student is writing a report on that topic, he or she must provide references to each point or topic or at least give the source of information. Suppose for statistical data the student must provide the source of the data. Data can be in processed form or raw, but it must be sourced properly. In case of figures if the figure is based on a particular topic it should be mentioned properly from where or which topic that figure has been constructed. Even if the figure is novel but still it does have a source from where the data has been taken to form a figure.
f. There are different forms of referencing a topic such as footnotes[1], which can be easily provided by using any documenting application. I have already given an example of a footnote along with the word. Another form of referencing is providing a number in square brackets [2] which is going to point to the reference number at the end of the text under the heading references.
g. A student must not copy anyone else's work. This is termed a plagiarism, which is a serious offence in the academic world. While writing an essay or an answer the student must keep in mind that there are tools that allow us to check for plagiarism and it would check the passage line by line.

Certain publications allow a certain percentage of plagiarism may be 5% to 10% as if the writings mostly deal with theoretical concepts which can't be changed, and those words must remain same to clearly state the point. In such cases a certain percentage of plagiarism can be tolerated.

h. The students must always remember that whatever type of writing they are working on be it a paragraph or an essay he or she must begin with an introduction and end with a conclusion. This a must for every type of writing.

All the above-mentioned rules must be seen as a framework based on which the student must write an essay or a paragraph. These rules are somewhat tough to follow when the student is answering a two marks questions. These can be followed while writing descriptive answers and any large answer or while writing an essay or a thesis.

2.3 Critical Thinking:

This is something the students really have trouble with. It is sometimes hard for them to think critically about a given topic and there are simple exercises that can be followed to help them think critically. They must understand that thinking critically means thinking about a topic in all directions or thinking deeply or researching on the given topic and getting oneself to understand the different aspects about a topic. In the following page I am going to give a simple exercise which the students can use it to start to think critically which may be of help for them when they learn how to think critically. They must use their skills to analyze the topic.

Exercise:

Let us show the students how they will usually describe an object and here I am going to give a picture of a computer mouse and let us see how most of the students are going to describe the mouse. Below the picture of the computer mouse is given.

Figure 2.1: Computer Mouse

(Source: en.wikipedia.org)

While describing the given picture the students may say the following:

a. This is a computer mouse.
b. It has Left button, right button and scroll wheel
c. It has a curved shape to fit in the palm.

d. It is an USB mouse
e. What is the price of the mouse?

So, the above points could be some of the things that a student will usually say about the computer mouse. Now if we ask the students to critically think about the computer mouse and what else do we know about the mouse? The students may give the following answers.

a. They will ask if the mouse is a gaming mouse or just a regular mouse.
b. What is the DPI (Dots per Inch) of the mouse?
c. Is it an optical mouse or a ball mouse?
d. Will it work on any given surface?
e. Are there any macro keys on the mouse?
f. Will it enhance the working experience?
g. Does this mouse have RGB lighting?
h. The quality of the electronic parts used to manufacture the mouse.

This may be some of the questions that can be asked by students and they can research on the given topic and find out the answers themselves. This not only is going to increase their knowledge about the topic but also is going to encourage them to think critically about the topic, which in turn is going to help them to write on a topic.

Critical thinking expands the horizon till which usually a student think. Sometimes students ask me what to write after writing about a few points.

This question really doesn't have a perfect answer as it completely depends on how the student is thinking and whenever I give my opinion it is going to be my thoughts that are projected in the given writing. In this cases what I usually do is I ask them some questions which is answered by the student and when they answer the question it opens up his or her mind to thinking critically on that topic in that path.

How to Prepare for Writing an Essay?

Let us unfurl the mysteries of essay writing. The point here is let the students understand how they can start by writing an essay. Whenever there is an essay type question it will have some specific words that are going to show the path of writing that student must follow to write the answer. According to Rolls and WIgnell (2013) these are called "Direction words". Some of the words include "describe", "explain", "discuss", etc.

Let's learn about what these words actually want us to achieve. Describe: When the question says describe it means to write about the facts or events. It has to be written in a systematic order. Emphasis must be given on the important points. There is no need to explain anything.

Explain: This is where the student must analyze the topic and it must not be just simply describing the topic. He or she must focus on the "why", "how" of the given topic. They must clearly state the reasons, causes and effects. Argue: This topic is about rejecting or accepting a point by presenting some evidence. Both the sides of the topic must be discussed and then the write may conclude with his or her opinion. Both the supporting and the opposing ends must be justified clearly and there should be any kind of bias while judging both ends.

Discuss: While we discuss on a point of view, we need to include the description and interpretation. The writer's or student's opinion must be supported by proper evidence. This sometimes looks like Argue type question but it's not. Here we just discuss on the given topic.

Critique: This also seems like an Argue where both negative and positive aspects of the topic is discussed and in the end the writer gives his or her opinion. Most of the time there are movie buffs who like to write critical analysis of the movies they watch. They take their time in watching a movie and they like to write about both the good and bad things that make up the movie and usually depending on the critiques the awards the given to the movie. So in a way criticism is a good thing as it improves the student's ability to comprehend good from bad.

Compare and Contrast: These are usually questions that find similarities and differences given between an idea or events. Both the ideas must be seen from both similarities as well contrast. This kind of questions raises the critical thinking of a student as he or she must critically understand the common and different parts of the ideas.

Some of the Examples of Essay Type Questions are:

a. National Education Policy 2020 is the newest policy of education since 1986. Describe and discuss the differences in both the policies.
b. Critically analyze the benefits of communication in an office environment.
c. Write an argument on online education.
d. Criticize the character of Lady Macbeth from the Play "Macbeth" by William Shakespeare.

All the above examples must be approached by the students in the manner they have been asked to. Writing anything other than asked is only going reduce the marks as well as the student is not going to learn properly the way of writing such questions. Each of the above questions must be researched properly before answering and marks of 10 to 20 can be allotted to these questions. Even the first topic can become a research topic if done properly, going through all the associated documents, raising the relevant question is going to give a proper writing topic.

2.4 Academic Essay:

An academic essay is one of the most essential forms of writing. It is made of thoughts which are now visible through the writing. The insights of the author occur at each line of the writing. The author always collects raw materials from the world such as different natural phenomenon or different texts and evidence. All these items must be ordered properly so that the readers are able to understand what is being written. Academic essays differ from discipline to discipline but a good essay is going to show growth in thesis development. The thesis must be written in such a way so that it is able to face criticism and provide counter measures to such. There should always be an anticipation of discovery.

a. Idea:

The essay must have an idea. The existence of such an essay is not enough there must be some idea that is going to grow throughout the thesis.

When a researcher is working on a topic he or she should always try to keep the idea as original as possible which should portray the use of different evidence on the research. The research may consists of reading and understanding text, using experiments to prove the points or observing a target to deduce behavioral traits of the target. The target could be human or animal. If the above mentioned things are not done then the thesis is going to be just boring. While working with the thesis the idea should be to make it original. The research topic must not be something trivial or something which is widely accepted.

b. Development of Thesis:

The thesis of an essay is the main point on which all the evidence must be pointed. The drafts of the thesis grow from time to time. Whatever or however the growth is, it increases the validity of the essay. Finally when the essay will be completed it will be at such a point where the thesis will be a valid document with all evidence. Students have an issue that they face while choosing a thesis topic. They think that what new idea could be generated from a topic which has already been researched by many scholars. A topic has unlimited vastness because there is no such topic that has been completely explored and there is nothing more to explore. Hence it is the task of the student to find such a place which is yet to be explored.

The student must be ready to take on surveys and researches on the internet. The student must be ready to work hard to achieve such feat. The student should also keep in mind wherever he is stuck he should be able to stop and take step back to reformulate his or her ideas.

This does not mean that he or she should stop researching but take time to create proper evidence to back the points in the thesis. One thing they have to understand from the beginning that the thesis is something complex which can only be solved by rigorous effort. To give a better viewpoint of the topic the student must intrigue the user by asking questions which are going to guide the research itself. This is where the student must start building the validity of the ideas. The other way to guide the reader through the paths taken by the author to complete the thesis.

c. Argument:

Argument is a competitive force that works from both the sides in a thesis. Where the thesis that is forwarded is being rejected by the authority on grounds of some ideas that are not yet proven. Hence the task of the student is to create or make such and argument that cannot be turned down by anyone, which is only possible if the work is backed up properly with enough evidence.

Even the smallest evidence can play a big role to create or enhance the thesis. While the readers might think that the small evidence is not yet enough the author can hold back a critical piece of evidence to surprise the readers in the end.

The author must remember to review the evidence as much as possible as it can generate an idea which was not there before or the evidence could be used as a counter argument. If the idea cannot be backed up properly it is good to leave the idea as it is rather than incorporating it in the thesis. Not a single piece of evidence must be hidden as it could weaken the idea in the long run.

d. Argument Structure:

An academic essay must be persuasive and the structure of an argument plays a vital role in this. The essay must be able to persuade the reader by setting up a stage, by providing a context and by deciding how to reveal the evidence. The objective of the essay must be described properly by a question or by making a statement that are going to lead the thesis.

There are some flexibilities provided to the author that he or she can reveal the aspects within a page or two. Sometimes the authors being a student makes a mistake just by giving a list of evidence rather than explaining it to the readers the occurrence of ideas and evidence. The conversation on the topic must not be too informal or else the argument may falter.

Deduction is the most common argumentative structure in English essay writing where the writing starts with generalization and then while providing proper evidence it moves on to specialization on a topic. Induction can also be used as a structure to work out facts or observations which can be reviewed and a conclusion can be drawn from it. Hence as we can see there is no correct approach for a successful essay. The best essays are those that focus on some point and use insightfulness to create a proper essay.

2.5 Structure of an Essay:

All works of writing must follow a structure which design the connected ideas to form an argument. Essays are never non-linear they follow a specific idea at a time, which must be presented to make the most sense out of it. If we are able to create an essay that a reader is able to understand properly then the essay has been structured properly. The structure of an essay depends on the focusing points. It guides the readers through what they should know and in which order it must be given. Therefore every essay structure has a uniqueness but there are some guidelines which the student or the author can follow.

2.6 Parts of an Essay:

An essay is divided into multiple parts where all the information is divided properly, even if the essays are short. It begins with an introduction to the argument followed by analysis of data, counteracting the arguments that are raised and ending with a conclusion. The beginning and end are fixed at their positions but the inner part of the essay may differ from person to person. Usually if there is any background discussion it is given in the beginning of the topic. It is always good to divide the essay in different sections as the readers may get the answers to their questions as they continue reading the thesis. The writing must create questions in the mind of the reader or else it is just a simple essay which doesn't have an observation or a fact that can be argued on.

The reader can ask "what" questions asking for evidence that proves the points discussed in the thesis. To answer the question the author must examine the evidence and demonstrate the data that they believe is to be true of nature. This section comes much early in the essay usually just after the introduction. In this section the data that has been strictly observed is posted and this is the part where the author is going say more about while starting to write. To balance the essay the author must keep in mind that this section must not take more than one third of the total essay or else the balance of the essay will be lost.

Next comes the "how" question and here the readers would like to if the claims of the author are true in all cases. The questions could be like if there are new sources how it will affect the observations of the author? How is the thesis material going to respond to counterargument? The essay must contain a section which discusses such questions. This section follow the "what" section.

The next section is "why", which is one of the most important part. Why the research on this topic? Why is it relevant to the current condition? This part answers the readers' questions on the larger context of the thesis and explains its significance. This is usually given at the end of an essay and omitting such is only going to make the reader feel that the author has not finished the work properly.

2.7 Essay Mapping:

Essay mapping means structuring an essay according to the reader. The author must understand what the reader expects to read next and need to know. The author must have an idea about the sequence that is to be used while writing the essay. It is easy to work out such an idea by writing down narratives, which is going to give the author a preliminary idea on how to record the ideas and at the start or end of every section the author is going to understand what the reader wants.

It is the task of the essay map to give the author an idea what the readers expects such as background information, counterargument, analysis of the sources etc. The readers expect to have major argumentative issues from an essay. Use the following ideas to create a map:

- The author must state the thesis in a few sentences, followed by the importance of the claims. It should mention why is important for the reader to follow your claims.
- The next part should begin by answering the above question. In another way background information can also be provided to answer the "what" question.
- Begin each of the following sentences like: "The reader needs to know…." Once again provide a topic and say why the reader needs to know and this should cover all the preliminaries that needs to be answered.

Essay maps must be flexible in nature and not rigid. It should be able to evolve the ideas of the author evolves. This mapping sometimes is called brainstorming.

Let us take an example and create a map. Topic: Write an essay on 1000 words on how rise in garment price is impacting people's shopping.

Map or Brainstorm

a. Clothes are important? Why? The basic reason is to drape but nowadays its fashion statement.
b. People are buying less clothes? Why? Costly. Why is it so costly?
c. Increase in cost of materials? Why? Increase in transportation cost. Why? Increase in price of petroleum products.
d. Solutions? Subsidy provided by government for material cost. Low cost clothes for everyone.

This is how a student should critically think and create a map of his or her work. This work can be more expanded but for this article I am keeping it short.

2.8 Taxonomy:

According to Rolls and Wignell (2013), a taxonomy is a way organizing information that groups things that are alike. After completing the map the student now must organize the ideas in a taxonomy. In the following figure the taxonomy of the above map is displayed.

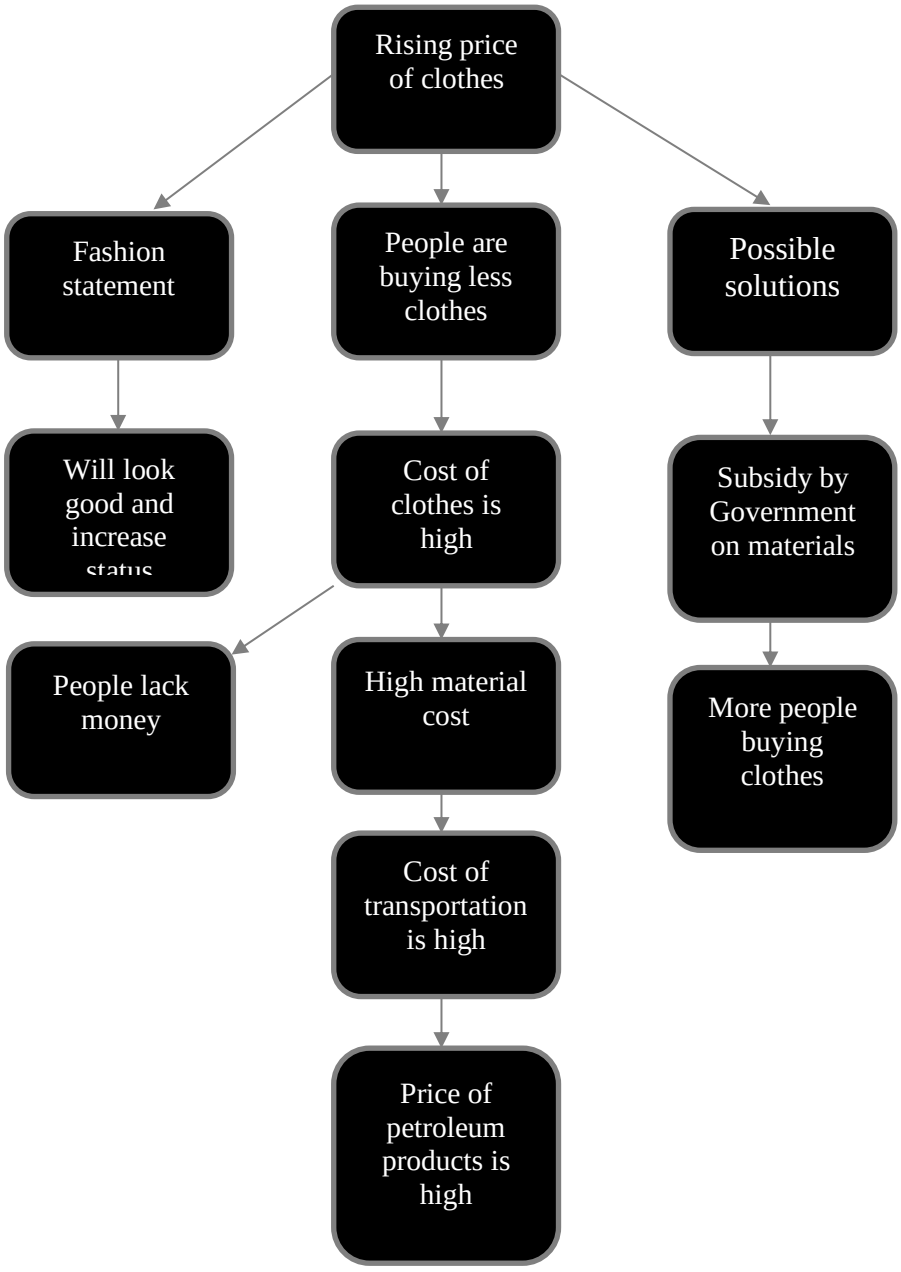


Figure 2.2: Taxonomy structure of an Essay

Let us now discuss what the most important aspects that a student must consider while writing an essay which is going to help him or her to score marks.

Usually a student thinks that keeping the grammar and spellings correct is going to help them score marks but in reality, the marks depend on variety of rubrics that we are going to discuss next.

Table 2.1: Marking Scheme of a Thesis

Heading	Points	To get maximum marks the essay must contain the following.
Essay Structure and Organization	5	Introduction: The thesis statement must be clearly related with the content of the essay.
	5	Content of Essay: It must be structured properly; the paragraph must be related, and the flow of information should be well enough
	5	Proper Language: The style of writing must be according to the purpose of writing and readers
	5	Conclusion: It must include the summarized version of the whole topic.
Content	25	Answers to the given question: It must be properly presented, and it should be consistent to the given question.
	25	Critical thinking: This section of the writing must point out the critically analyzed data as well as different points of view.
Evidence Quality	15	Research data: The research data must be relevant and backed by evidence and credible sources.
	5	The list of references and footnotes must accurate. If there is an index it should also match properly.
Grammar	8	The sentence structure must be very clear and error free
Formatting	2	The formatting of the document must be according to instructions given by the teacher, board or university. Formatting means using different font types and sizes as given.

2.9 Structure of an Academic Essay:

According to Rolls and Wignell (2013) the structure of an essay may appear overly perspective but it does provide an excellent framework for a student who is beginning to write an essay or a student having difficulty in structuring an essay.

The structure of an essay can be used to accommodate the complex answers of an essay. After completing the map and taxonomy the student now must focus on arranging the paragraphs and put them according to the essay structure.

Usually some universities have system where the language must be in third person until and unless the essay asks for personal reflection.

Table 2.2: An Academic Essay Structure (Rolls and Wignell, 2013, p55)

Introduction	
	General Statement Thesis Statement Outline of Main Ideas That Will Be Discussed By The Student.
Body of Essay	
	Paragraph A Topic Sentence Supporting Evidence 1 Supporting Evidence 2 Supporting Evidence 3 Supporting Evidence 4
	Paragraph B Topic Sentence Supporting Evidence 1 Supporting Evidence 2 Supporting Evidence 3 Supporting Evidence 4
	Paragraph C Topic Sentence Supporting Evidence 1 Supporting Evidence 2 Supporting Evidence 3 Supporting Evidence 4
Conclusion	
	Summary of Main Point, Final Comment

2.10 Thesis Statement:

A thesis statement is the most important statement in the introduction of an essay as it positively states that what the essay is going to be about. There are different ways of writing a thesis statement but for a beginner the easiest way to write a statement is to use the essay question and convert it into a statement. The statement is also used to restrict the scope of the essay. According to Rolls and Wignell (2013) there is no right way to create a thesis statement. The only important thing is what the thesis statement is pointing at. The following example is used by Charles Darwin University as they state how the students should be able to identify the thesis statement.

A. Essay Question 1:

What is meant by the term Globalization? Discuss the effects of globalization on at least one of the following:

- Trade
- Business
- Consumerism
- International relations
- The arts

a. Thesis Statement 1a:

The essay will discuss the positive and negative effects of globalization in relation to consumerism, trade and business.

b. Thesis Statement 1b:

The essay begins by defining what is meant by globalization and discusses the positive effects of globalization on the arts in Australia.

B. Essay Question 2

Despite its negative health effect the tobacco industry remains an important part of the economy of many nations. Discuss the economic effects of the tobacco industry in relation to at least one of the following level of industry.

- Primary level (farmers)
- Secondary level (small business)
- Tertiary level (government revenue)

a. Thesis Statement 2a:

This essay will show that the economic benefits of the tobacco industry are beneficial to the global economy at the primary, secondary and tertiary levels of the industry.

b. Thesis Statement 2b:

Despite its negative health effects the tobacco industry remains an important part of the Australian economy. This essay will discuss how the federal government tax regime on the industry currently brings in more money than is spent on tobacco related diseases.

c. Writing Introduction:

The introducing paragraph is the most important part of an essay. As it sets out the thesis statement and gives the reader clear signals for what they are going to read.

An introduction should contain the following:

- Background information
- Thesis statement
- Outline
- Scope

The following example is provided by Rolls and Wignell (2013, p58)

- Background: In the past two years the threat of cane toads to the top end of Australia has become an increasing reality. Their numbers continue to steadily increase in Kakadu National Park and they are causing damage to this pristine environment.
- Thesis statement: This essay will discuss the effects of cane toads on the environment of the Kakadu national park and show that they will cause permanent damage to the environment.
- Outline: this will be seen, firstly by discussing the characteristics of cane toads and then, examining their predicted long term effects on the animals of Kakadu and the tourist industry.
- Scope: Because there is data available only on the effects of cane toads on goanna, frogs and crocodiles these are the only animals that will be discussed.

Paragraph:

These are the building blocks of an essay. In academic essays a paragraph introduces the topic and provides evidence along with it. These evidences must be properly referenced. The main idea of the topic is called topic sentence.

It provides the reader with a map of what is expected throughout the paragraph. The flow of the essay must be proper so that the reader can read flawlessly and to do that it must be linked using linking words such as the following:

- To begin
- To conclude
- In addition
- In the same way
- In this case
- In other words
- In contrast
- To summarize

The following paragraph has been adapted from Rolls and Wignell (2013, p.63)

Topic sentence: Adults should read to infants.

Supporting evidence: Smith and Brown (2010) explains that this helps them to read at a later stage because it helps them to see the association of words at a later stage. This also helps them to have a positive experience in life.

Reviewing the Draft: After completing the draft of the essay have gained a lot of perspective. We can at this point stand and say that whether or not the matter was complex. While writing the essay we may have discovered some to the topics which were not there before we had started thinking or mapping. So what we should do now is to revise the draft. The following are the steps that we should follow.

- Stay away from the draft and go through self-evaluation
- Give the draft to someone else and get feedback from them, it is a great way to achieve. Have someone over to discuss the matter with, even create a debate on the matter. Hear someone else's mind.
- The outline of the essay must be in your mind. Sort out the paragraph according to their importance in your work.
- Backtrack your work. Restructure the data once again from the beginning or the end.
- Now at this point you have gathered a lot of data so therefore you must work on the introduction and conclusion.
- Proofread your work. You can do it yourself or you can also ask someone else to proofread work. You wouldn't want to have simple grammatical or spelling error.
- You should keep in mind that revision means rethinking your thesis. You will be able to see more clearly because at this point you have gained a lot of experience on the given topic. The more you revise your thesis is going to evolve. While revising you have the chance to think on the given topic and carry more insight on that.
- You should focus on making structural changes wherever necessary. To evolve your idea and making your idea more precise you must go through the whole paragraph and make changes to it rather than making small changes to the individual sentences. Remove unwanted words, shorten the writing for clear and crisp words.
- Do not take any shortcuts while revision. This is one of the mistakes that students make that they do not go through their work thoroughly. So, take your time and revise the essay.

2.11 Editing an Essay:

After completing the revision on the draft, it is time to edit the essay. While revising we had to go through the work once again from beginning to end. So after marking the parts that needs to change it is now time to change it. The problem at the beginning may seem to be very small but a poorly constructed phrase could be misunderstood by the readers, which could lead to misunderstanding the topic itself. So follow the rules mentioned below to keep those mistakes at bay.

a. Reading the essay aloud is going to let our ears pick up the disturbance in the tone of writing which could easily be missed by our eyes. While reading the punctuation marks help us to provide intonation and the tone would be disturbed if any such phrases are there that causes irritation in our ear can be removed.
b. We must be sure that the choice of our words are going to mean what we want them to mean. What I mean to say by this is there should not be any ambiguity in the meaning of the words. If it is there that means you have made a poor choice of words. Make the sentences shorter if those short sentences can convey your mind. Rather than using long sentences to make a line, optimize the sentence with proper words. Even small, apparently unimportant words like "says" are worth your attention.

Instead of "says," could you use a word like argues, acknowledges, contends, believes, reveals, suggests, or claims? Words like these not only make your sentences livelier and interesting, they provide useful information: if you tell your readers that someone "acknowledges" something, that deepens their understanding of how or why he or she said that thing; "said" merely reports.

c. To convey to your readers what you exactly want to convey you must use precise words and language. Without these concrete words and clear language, the readers won't be able to understand what you want to say. Generalization is not a way to write your sentences, it gives vague meaning to the sentence and it is going to apply to anyone but there are chances that this may not apply to the reader, in that case the reader will get confused. For example: "The evils of society are a drain on our resources." Sentences like this could mean so many things that they end up meaning nothing at all to your readers—or meaning something very different from what you intended. Be specific: What evils? Which societies? What resources? Your readers are reading your words to see what you think, what you have to say. Use a thesaurus if you are having trouble finding the right word. Nowadays applications like Microsoft Word 365 provides a huge library of words in its dictionary and thesaurus. While writing you might get suggestions to shorten phrases with words.
d. Authors some time get excited while writing and tend to write down jargons to make their work more authoritative. The author must reconsider using such phrases as in the beginning it may make the author look smarter but the readers are smarter too who can easily catch the writer's intellect. And if the writer isn't smart at all that kind of language is not going to help at all. For example: Sentence 1: "He exited the room. It is important that proponents and opponents of this bill dialogue about its contents before voting on it." The same sentence written in a much simple way. Sentence 2: "He left the room. People should debate the pros and cons of this bill before voting."
e. We should let of the brilliant and favorite sentences which will only create a false belief in our mind. We're all guilty of trying to sneak in our favorite sentences where they don't belong, because we can't bear to cut them. But great writers are ruthless and will throw out brilliant lines if they're no longer relevant or necessary. They know that readers will be less struck by the brilliance than by the inappropriateness of those sentences and they let them go.
f. We should always avoid using same sentence structure. We are not writing a poem here so we can vary our sentence structure and use different of different length.
g. Avoid using phrases that the readers always hear, this is only going to put your essay behind in the race. Phrases that the readers hear regularly lose the impact and even if the voice in the essay is fresh it is something that the readers are going to avoid. In some cases it may these phrases that are going to help but those are exceptional cases and should not be taken as an example.

2.12 Conclusion:

Throughout the article we focused on different aspects of writing an essay. Beginning with the aims of writing an essay, moving on to different aspects of describing and referencing. The students are going to be able to at least begin their journey on writing essays and thesis. This text is going to be helpful for everyone. The language used in this article is as simple as possible so that all types of readers can go through the text and understand the meaning. There could be so many examples provided but I hope I have provided with necessary examples where ever possible. To conclude I would like to say that writing conveys our mind.

Some writing are for the public and some private, whatever it may be writing helps us to speak out our mind.

2.13 References:

1. https://writingcenter.fas.harvard.edu/pages/strategies-essay-writing
2. https://writingcenter.fas.harvard.edu/pages/overview-academic-essay
3. https://writingcenter.fas.harvard.edu/pages/essay-structure
4. https://writingcenter.fas.harvard.edu/pages/developing-thesis
5. https://writingcenter.fas.harvard.edu/pages/beginning-academic-essay
6. https://writingcenter.fas.harvard.edu/pages/outlining
7. https://writingcenter.fas.harvard.edu/pages/counter-argument
8. https://writingcenter.fas.harvard.edu/pages/summary
9. https://writingcenter.fas.harvard.edu/pages/topic-sentences-and-signposting
10. https://writingcenter.fas.harvard.edu/pages/transitioning-beware-velcro
11. https://writingcenter.fas.harvard.edu/pages/how-write-comparative-analysis
12. https://writingcenter.fas.harvard.edu/pages/ending-essay-conclusions
13. https://writingcenter.fas.harvard.edu/pages/revising-draft
14. https://writingcenter.fas.harvard.edu/pages/editing-essay-part-one
15. https://writingcenter.fas.harvard.edu/pages/editing-essay-part-two
16. https://en.wikipedia.org/wiki/Computer_mouse
17. https://www.scribbr.com/category/academic-essay/
18. https://grammar.yourdictionary.com/writing/how-to-write-an-essay.html
19. https://www.fastweb.com/student-life/articles/essay-tips-7-tips-on-writing-an-effective-essay
20. https://www.internationalstudent.com/essay_writing/essay_tips/
21. https://www.ukessays.com/guides/how-to-write-an-essay.php
22. https://www.edx.org/course/how-to-write-an-essay
23. https://www.time4writing.com/writing-resources/step-by-step-guide-to-writing-an-essay/
24. https://www.educationcorner.com/writing-an-essay.html

ISBN: 978-93-90847-07-5

Chapter - 3 : Mixed Research Method

Deblina Talukdar

Lecturer in Kishore Bharati Bhagini Nivedita College (Co-Ed),
University of Calcutta, West Bengal, India.

&

Jayanta Mete

Professor, Department of Education, University of Kalyani, Kalyani, Kalyani,
West Bengal, India.

3.1 Introduction:

From the advent of primitive time human beings always have a natural quest to know more about the environment and they always seek answers to their findings or their problems.

This way they became capable to solve the problems or they became able to find the answers of their curious situation, for that they gathered maximum information from different sources.

This creates a beginning in the way of Research. So, Research implies the discovery of truth for which we follow certain scientific methods as research is an intellectual activity undertaken with the ultimate aim of scientific accomplishment and scientific creation or invention.

In the meanwhile different research methods started emerging and each of these methods has their own relative strength and weakness.[1]

On the basis of broad research methodology, there are two approaches of research- Qualitative research and Quantitative research.

3.2 Qualitative Research:

Qualitative Research method has its deep origin in social science and the premise of its origination is to help researcher to study the phenomena from socio-cultural orientation.

It involves the use of qualitative data such as interview, documents, observation, questionnaire and the researcher's impression and perception.

Qualitative research serves one or more purposes (Perskin, 1993)

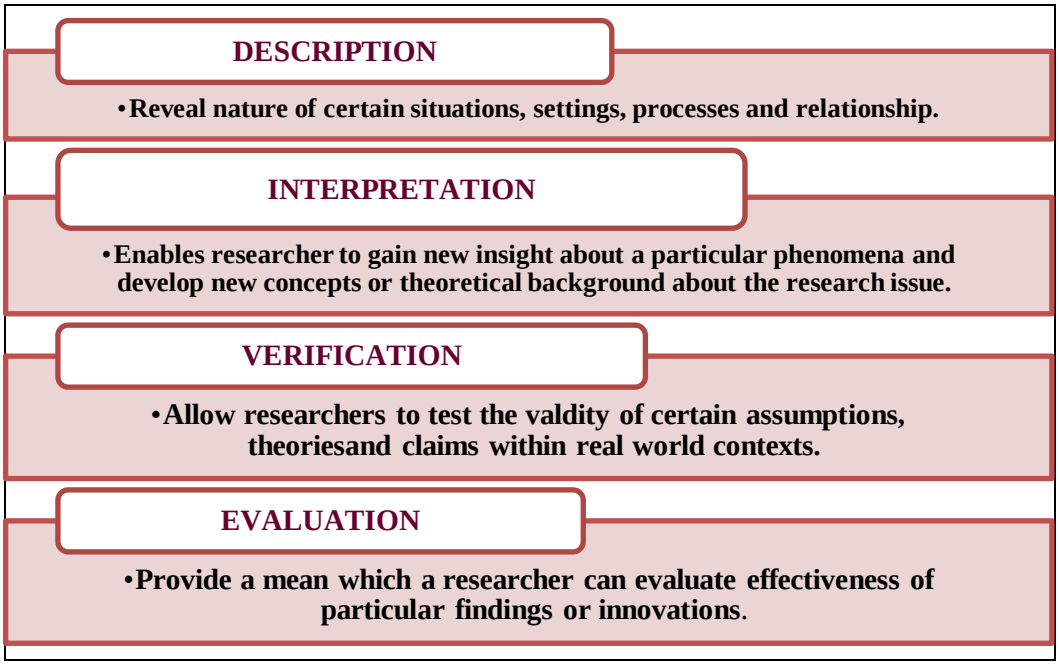


Diagram 3.1: Showing Purpose of Quality Research (Perskin, 1993).

Source: file:///C:/Users/user1/Downloads/20110021_22_research_methodology.pdf

3.2.1 Types of Qualitative Research:

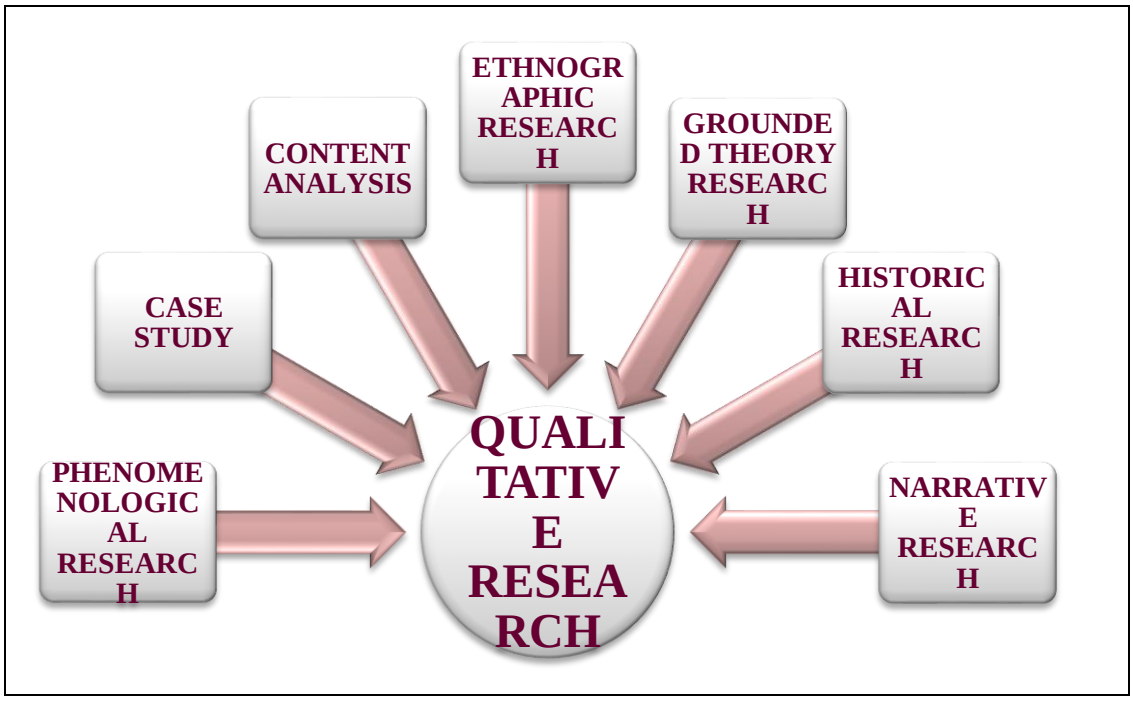


Diagram 3.2: Showing Types of Qualitative Research.

Source: https://www.slideshare.net/kerbala2013/types-of-qualitative-research

3.2.2 Quantitative Research:

Quantitative Research refers to a systematic investigation of phenomena by gathering numerical data and performing statistical, mathematical, or computational techniques.

Here researchers deploy mathematical frameworks and theories that pertain to the quantity under question.[3]

It relies on collection and analysis of numerical data to describe, explain and predict to control variables and phenomena of interest. (**Gay, Mills and Airasian, 2009**).

There are certain purposes of quantitative research which are given below:

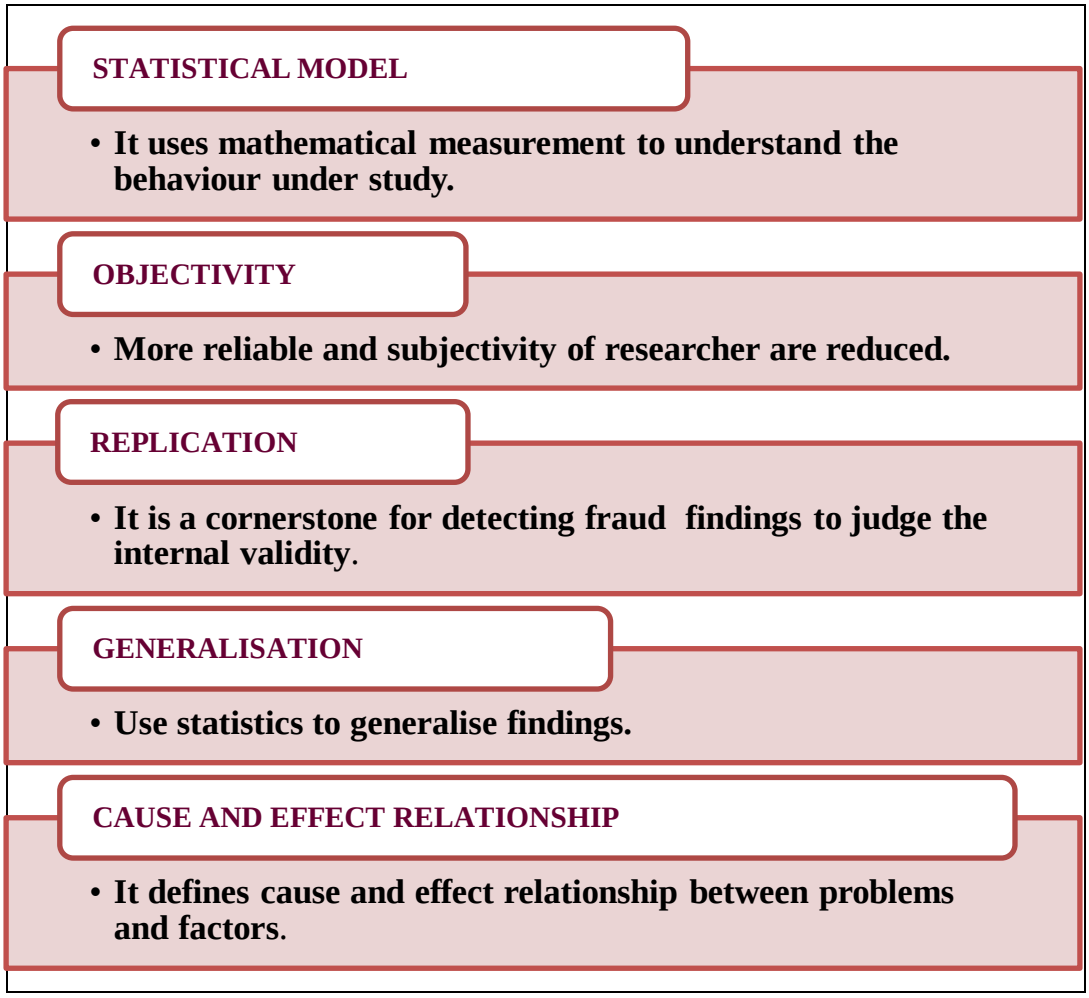


Diagram 2: Showing the Purposes of Quantitative Research.

Source: https://www.le.ac.uk/oerresources/lill/fdmvco/module9/page_45.htm

3.2.3 Types of Quantitative Research:

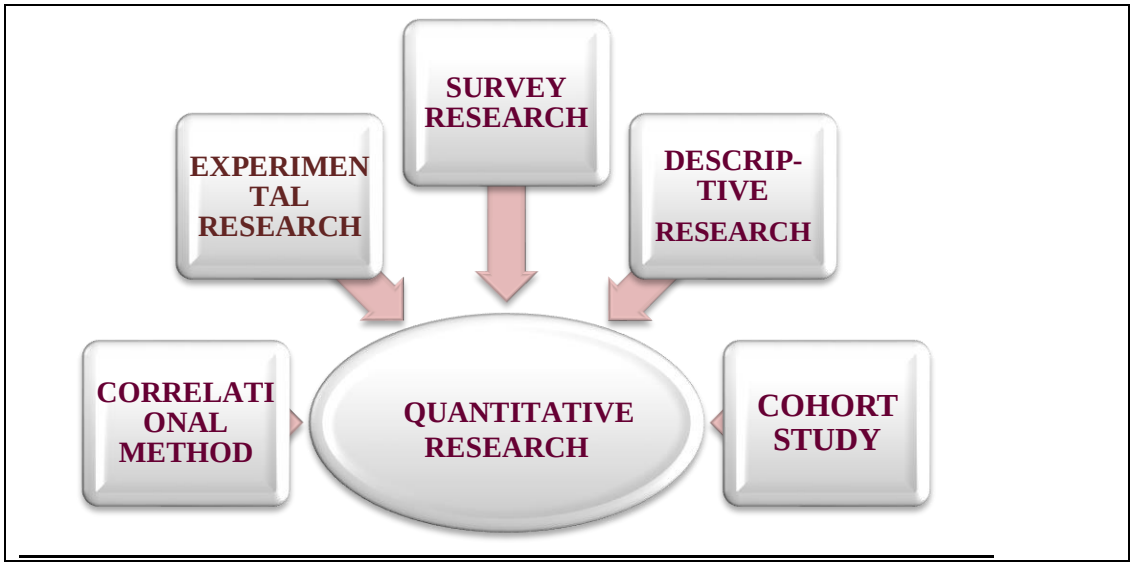


Diagram 3.3: Showing Types of Quantitative Research

Source: Investigator's Self Made:

Both quantitative and qualitative researches have their characteristics, assumptions and purposes. Both qualitative and quantitative research methodologies have weaknesses when used alone. By involving both the methodologies researcher gain expanded knowledge about the research problem. Recently in research field investigators were interested in combining the both the methodologies (quantitative and qualitative) provide broad range of perspective on the problem of research.

3.3 History of Mixed Research Methodology:

The history of Mixed Research Methodology can be traced back from to the 18th century. It was **Creswell and Plano Clark (2011)** date the beginnings of mixed-methods research back to the mid- to late 1980s. Methodology experts and writers from all around the world seemed to have been simultaneously working on similar ideas regarding the combination of quantitative and qualitative methods. Up to this point in time, many qualitative researchers and quantitative researchers did not see the legitimacy in the other approach to doing research. However, members of both research camps began to realize, on a deeper level, the value of the alternate approach.

For example, quantitative researchers began to see that qualitative data could play an important role in quantitative research; similarly, qualitative researchers began to see that reporting only qualitative views of the world – and of a few individuals – would not permit generalization of the findings to many other individuals and audiences **(Creswell & Plano Clark, 2011).** Over the past decade or more, interest in the use of mixed-methods research as a means for studying educational topics and phenomenon has grown substantially. Reported by

Again, **Hesse- Biber reported (2010**) that both the paradigm of qualitative and quantitative approaches were used to study the poverty of Europe in the year 1850 **(Le, Play 1855**). Again, **W.E.B. DuBois (1899**), both statistical and observational data and applied in the study of

The ***Philadelphia Negro.*** **Camphell and Fiske (1859**) in order to strengthen the validity of research conclusion as well as to measure several traits mixed method was used in the study. So, during the period of 1970s and 1980s was the argument that the epistemological differences between the qualitative and quantitative paradigms made them fundamentally incompatible. This 'incommensurability thesis' created a dilemma for researchers who used methods of both qualitative and quantitative orientation in their studies. In order to justify use of multiple methods, the notion of triangulation as a superior approach was brought to the fore. Here, mixed methodologists had an 'edge' in being able to capitalize on the strengths of each paradigm whilst offsetting their weaknesses. Thus, a central premise of mixed methods became that "the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone" **(Creswell and Plano Clark 2007:5).** This is based on the logic that "one cannot separate methods from the larger process of research of which it is a part" **(Tashakkori and Creswell 2007:304).**[4]

3.3.1 Meaning of Mixed Method Research:

A **Mixed method** refers to an innovative methodology of research that progresses the systematic integration or mixing of quantitative and qualitative data within a single investigation or sustained programme of inquiry. The basic assumption of such research helps to integrate a more complete and synergetic utilization of data, instead of separating the quantitative and qualitative methodologies for the purpose of collecting and analyzing the data. So it is a method for conducting research that involves collecting, analyzing and integrating and quantitative and qualitative researches. By mixing both the paradigms the researcher gains breadth and depth of understanding and corroboration (evidences which supports findings). That is why it is multiple methods to explore research problem.

3.3.2 Definitions:

This definition is almost identical to that given in the Handbook of Mixed Methods Research **(Creswell and Plano Clark 2007:5)**:

"**Mixed method** is a research design with philosophical assumptions as well as methods of inquiry. As a methodology, it involves philosophical assumptions that guide the direction of the collection and analysis of data and the mixture of qualitative and quantitative approaches in many phases in the research process. As a method, it focuses on collecting, analyzing, and mixing both quantitative and qualitative data in a single study or series of studies".

Jonson, Onwuegbuzie and Turner (2007:118), who sought to formalize a definition by synthesizing the perspectives from 31 'leaders' in the field. They concluded that: "mixed methods research is the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purpose of breadth and depth of understanding and corroboration".

Valerie Caracelli: A mixed method study is one that plan fully juxtaposes or combines methods of different types (qualitative and quantitative) to provide a more elaborated understanding of the phenomenon of interest (including its context) and, as well, to gain greater confidence in the conclusions generated by the evaluation study.

Steve Currall: Mixed methods research involves the sequential or simultaneous use of both qualitative and quantitative data collection and/or data analysis techniques.

Marvin Formosa: Mixed methods research is the utilization of two or more different methods to meet the aims of a research project as best as one can. The research project may be conducted from either one or two paradigmatic standpoints (mixed methodology study).

Jennifer Greene: Mixed method inquiry is an approach to investigating the social world that ideally involves more than one methodological tradition and thus more than one way of knowing, along with more than one kind of technique for gathering, analyzing, and representing human phenomena, all for the purpose of better understanding.

Hunter: Mixed method is a term that is usually used to designate combining qualitative and quantitative research methods in the same research project. I prefer the term multi method research to indicate that different styles of research may be combined in the same research project.

These need not be restricted to quantitative and qualitative; but may include, for example, qualitative participant observation with qualitative in-depth interviewing. Alternatively it could include quantitative survey research with quantitative experimental research. And of course it would include quantitative with qualitative styles.[5]

Burke Johnson and Anthony Onwuegbuzie: Mixed methods research is the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study or set of related studies.

3.4 Why to Use Method in Research?

3.4.1 Triangulation:

The researcher needs to use mixed method to convergence, corroborate or to validate result from different methods. Mixed methods research focuses on triangulation that spans multiple methodologies **(Denzin, 1970, 2012; Singleton & Straits, 1999).**

Jick (1979) argues that methods-spanning forms of triangulation are on the complex end of a continuum of triangulation design while within-method forms are on the simple end.

This reflects the view that using multiple methods produces more valid results as the strengths of one method can offset the limitations of another method (**Jick, 1979; Scandura & Williams, 2000).**

3.4.2 Complementarity:

When the researcher wants to elaborate, enhance, extended illustration, or to clarify the result of a method. the idea of complementarily also found a solid home in the social sciences. One way of knowing the problem is from the perspective of inside, i.e., involving the entry level of problem and the other one is when we are viewing the problem from outside and researcher generally encircles the problem inside („looking in", or Verstehen—qualitative approaches), or examining these actions from the Outside („looking at", or Erklären—quantitative approache.

3.4.3 Development:

When the researcher in a need to use one method to help and develop the other method. **Mixed methods** are especially useful in understanding contradictions between quantitative results and qualitative findings. It reflects participants' point of view. **Mixed methods** give a voice to **study** participants and ensure that **study** findings are grounded in participants' experiences. This aspect urges researchers to carefully plan their works with intentional choices that can leverage integration. The issue is to produce a whole through the integration that is greater than the sum of the individual parts of both methods.

3.4.4 Initiation:

When looking for contradiction and new perspectives. The result of one method may be used to examine and change the question for the other. The prime focus of researcher is to obtain divergent information. Purposeful data integration enables researchers to seek a more panoramic view of their research landscape, viewing phenomena from different viewpoints and through diverse research lenses.

3.4.5 Expansion:

When the researcher want to expand the breadth, depth and range of research by using different methods and various ways of inquiring results in more comprehensive outcome. This will definitely expand the scope of undertaken study. In the **European Journal of Educational studies, (2018) author Fernando Almeida** cited that, **Toomela (2008), Ponterotto et al. (2013) and McKim (2017**) emphasize that mixed methods research helps the researcher to deeply and accurately understanding of the phenomena under study. **Bamberger (2012)** complements this vision by advocating that mixed methods research promote greater understanding of stakeholder perspectives on the nature of the intervention.

3.4.6 Theory Building:

Optimally, all studies draw upon one or more theoretical frameworks from the social, behavioral, or biological sciences to inform all phases of the study. Mixed methods studies provide opportunities for the integration of a variety of theoretical perspectives (e.g., ecological theories, complexity theory, stress theory, critical theories, or others). When researcher want to develop a theory about a phenomenon of interests Mixed and after testing it a theory is generated. There is a gradual use of quantitative and qualitative methods. First, the qualitative method is used and the results are intended to contribute to the development of

the quantitative research process. The nature of qualitative research and its evidence: A salient strength of qualitative research is its focus on the contexts and meaning of human lives and experiences for the purpose of inductive or theory-development driven research. Qualitative data help researchers understand processes, especially those that emerge over time, provide detailed information about setting or context, and emphasize the voices of participants through quotes.

Qualitative methods facilitate the collection of data when measures do not exist and provide a depth of understanding of concepts. Quantitative research is a mode of inquiry used often for deductive research, when the goal is to test theories or hypotheses, gather descriptive information, or examine relationships among variables. These variables are measured and yield numeric data that can be analyzed statistically. Quantitative data have the potential to provide measurable evidence, to help to establish (probable) cause and effect, to yield efficient data collection procedures, to create the possibility of replication and generalization to a population, to facilitate the comparison of groups, and to provide insight into a breadth of experiences.

This integration consists of combining the qualitative data in the form of texts or images with the quantitative data in the form of numeric information. This integration can be achieved by reporting results together in a discussion section of a study, such as reporting first the quantitative statistical results followed by qualitative quotes or themes that support or refute the quantitative results.

It also can be achieved by transforming one dataset (e.g., counting the occurrence of themes in a qualitative dataset) so that the transformed qualitative results can be compared with the quantitative dataset **(Sandelowski, Voils, & Knafl, 2009**).

3.4.7 Generalization: Generalization:

which is an act of reasoning that involves drawing broad inferences from particular observations, is widely-acknowledged as a quality standard in quantitative research, but is more controversial in qualitative research. The goal of most qualitative studies is not to generalize but rather to provide a rich, contextualized understanding of some aspect of human experience through the intensive study of particular cases. Mixed methods research, which involves the collection, analysis, and integration of qualitative and quantitative data within a study or coordinated series of studies, appears to hold promise for generalizability.

In the **International Journal of Nursing Studies, by Denise F. Polit. and Cheryl Tatano Beck** it is being cited that larger and more representative samples in the quantitative strand of mixed methods studies can promote confidence in generalizability in the classic sense. Well-grounded meta-inferences **(Teddlie and Tashakkori, 2009)** based on rich, complementary data sources can enhance analytic generalization.

And rich and diverse descriptive information from two types of data source can promote an understanding of proximal similarities and hence transferability. Interest in mixed methods research is growing rapidly, and exciting developments are also occurring with regard to mixed methods integration **(e.g., Flemming, 2010; Plueye et al., 2009)**.[6]

3.4.8 Instrument: Generally, there are various procedures of collecting data. The main instruments used in the mixed method researches consist of closed-ended, open-ended questionnaires, interviews and classroom observations.

These different ways of gathering information can supplement each other and hence boost the validity and dependability of the data.

In the main, the quantitative data are obtained through closed-ended questionnaires and the qualitative data through open ended questionnaires, interviews and classroom observations.[7] **provides an approach for developing better, more context specific instruments**.

For instance, by using qualitative research it is possible to gather information about a certain topic or construct in order to develop an instrument with greater construct validity, i.e., that measures the construct that it intends to measure.

3.5 Different Aspects of Mixed Research Method:

Bryman (2006) formulated a list of more concrete rationales for performing mixed methods research.

Bryman's classification breaks down **Greene et al.'s (1989)** categories into several aspects, and he adds a number of additional aspects, such as the following:

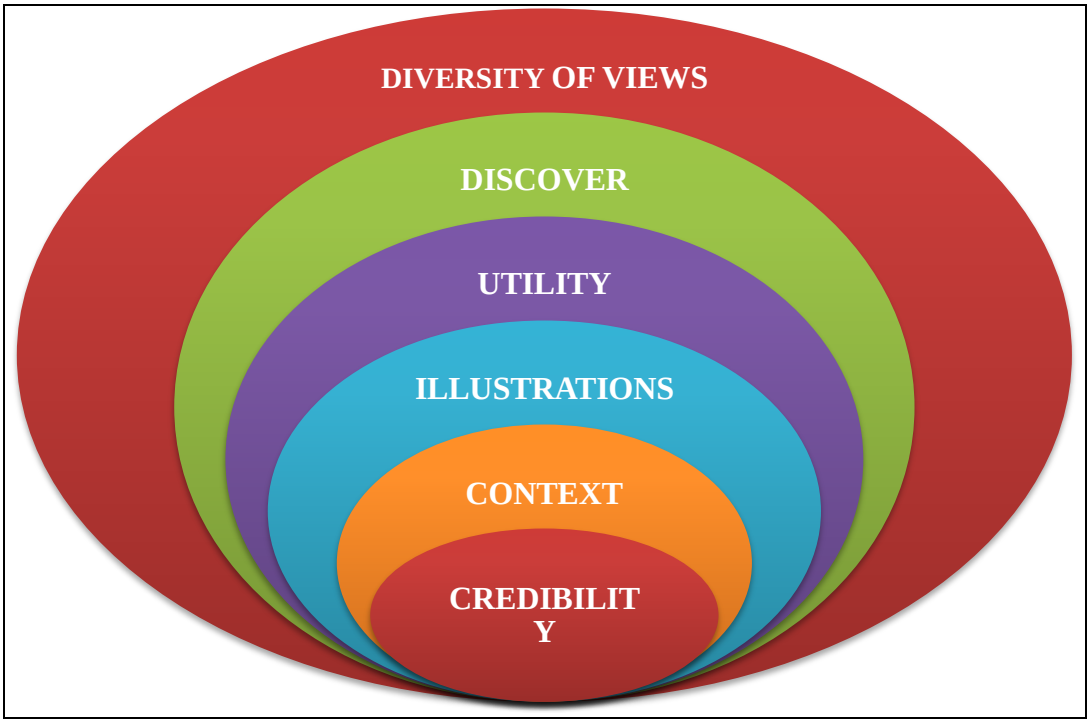


Diagram 3.4: Showing Different Aspects of Mixed Research Method

Source: https://link.springer.com/article/10.1007/s11577-017-0454-1

3.5.1 Credibility: refers to suggestions that employing both approaches enhances the integrity of findings.

3.5.2 Context: refers to cases in which the combination is justified in terms of qualitative research providing contextual understanding coupled with either generalizable, externally valid findings or broad relationships among variables uncovered through a survey.

3.5.3 Illustration: refers to the use of qualitative data to illustrate quantitative findings, often referred to as putting "meat on the bones" of "dry" quantitative findings.

3.5.4 Utility or Improving the Usefulness of Findings: refers to a suggestion, which is more likely to be prominent among articles with an applied focus, that combining the two approaches will be more useful to practitioners and others.

3.5.5 Conform and discover: this entails using qualitative data to generate hypotheses and using quantitative research to test them within a single project.

3.5.6 Diversity of Views: this includes two slightly different rationales – namely, combining researchers' and participants' perspectives through quantitative and qualitative research respectively, and uncovering relationships between variables through quantitative research while also revealing meanings among research participants through qualitative research. **(Bryman, p. 106)**

3.6 Typology of Mixed Research Method:

3.6.1 Sequential Explanatory Strategy:

This is the popular among the others that appeal to researcher with strong quantitative background. In this typology researcher first collect and analyses quantitative data followed by the collection and analysis of qualitative data in the second phase that builds on the result of the initial quantitative paradigm.

The mixing or integration of data occurs when the initial quantitative outcome informs the secondary qualitative data collection. Thus the form of data collection separated but connected.

The overall purpose of this design is to use a qualitative strand to explain initial quantitative results **(Creswell, Plano Clark, et al., 2003).**

For example, the explanatory design is well suited when the researcher needs qualitative data to explain quantitative significant (or non-significant) results, positive-performing exemplars, outlier results, or surprising **results (Bradley et al., 2009; Morse, 1991).**

So this form of strategy begins with the explanation and interpretation of quantitative outcome by collecting and analyzing qualitative outcome.

It generally arises when unexpected outcome arises from the quantitative then the qualitative data collection that follows can be used to examine the details. For example survey method was used then interview method on group members to get deep insight about the responses of survey, to assist findings in quantitative study.

3.6.1.1 Strength:

- It is easy to implement because the steps fall to clear and separate stages.
- It is very easy to describe and to report.
- The final report can be written with a quantitative section followed by a qualitative section, making it straightforward to write and providing a clear delineation for readers.
- This design lends itself to emergent approaches where the second phase can be designed based on what is learned from the initial quantitative phase.

3.6.1.2 Weakness:

- It takes long duration of time for data collection of two different phases.
- If two different phases are given equal priority then it acts as a great drawback.

The researcher must decide who to sample in the second phase and what criteria to use for participant selection. Chapter 6 explores approaches to using individuals from the same sample to provide the best explanations and criteria options, including the use of demographic characteristics, groups used in comparisons during the quantitative phase, and individuals who vary on select predictors.

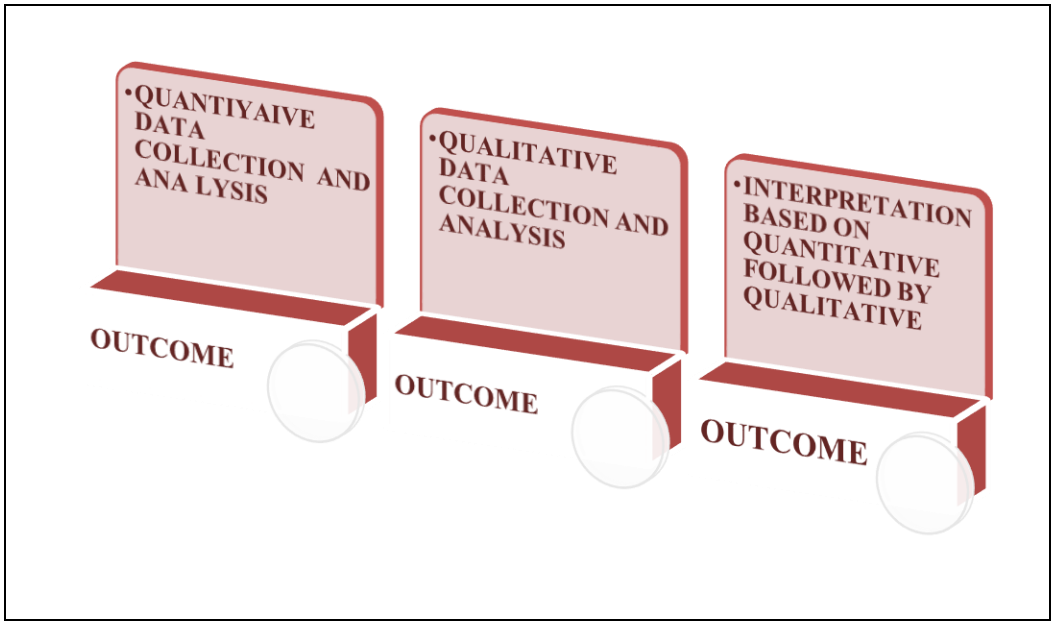


Diagram 3.5: Showing Sequential Explanatory Strategy.

(Source: Investigator Self Made)

3.6.2 Sequential Exploratory Strategy:

The Sequential Exploratory is almost identical to the Sequential Explanatory Strategy except their phases are reversed with each other. Here in the first phase instead of quantitative, qualitative data collection and analysis were carried on followed by the quantitative data collection and analysis in the second phase, which builds on the result of the first qualitative phase. Weight is actually given to the first phase and data are mixed through while establishing connection between qualitative data analysis and quantitative data collection. But it is also true that the design may not be implemented within explicit theoretical perspective. The purpose of this typology is to utilize quantitative data and results simultaneously in order to provide assistance in the interpretation of qualitative findings. The purpose of such strategy according to **Morse** is to determine distribution of phenomena within chosen population. It is often described as procedure of choice when the researcher needs to develop an instrument, because the existing instruments are inadequate or it is not available. The primary purpose of the exploratory design is to generalize qualitative findings based on a few individuals from the first phase to a larger sample gathered during the second phase.

As with the explanatory design, the intent of the two-phase exploratory design is that the results of the first, qualitative method can help develop or inform the second, quantitative method **(Greene et al., 1989)**.

This design is based on the premise that an exploration is needed for one of several reasons: (1) measures or instruments are not available, (2) the variables are unknown, or (3) there is no guiding framework or theory.

Because this design begins qualitatively, it is best suited for exploring a phenomenon (Creswell, Plano Clark, et al., 2003).

This design is particularly useful when the researcher needs to develop and test an instrument because one is not available **(Creswell, 1999; Creswell et al., 2004)** or to identify important variables to study quantitatively when the variables are unknown.

For example, conduct a survey to develop classification for testing or identifying the variables.

Researcher uses information from different sources like journals or diaries in order to develop a survey and to administer it on larger samples.

3.6.2.1 Strength:

- It is easy to implement as it is straight forward to describe the report.
- It is useful for those researchers who wants to explore phenomena as well as also wants to expand qualitative findings.
- Although this design typically emphasizes the qualitative aspect, the inclusion of a quantitative component can make the qualitative approach more acceptable to quantitative-biased audiences.
- This design is useful when the need for a second, quantitative phase emerges based on what is learned from the initial qualitative phase.

3.6.2.2 Weakness:

- It needs prolonged period of time to complete both data collection phases which acts as a drawback in the research process.
- Researcher has to make key decision about which findings from the initial qualitative phase will be focused on in the subsequent quantitative phase.
- Researchers should consider using a small purposeful sample in the first phase and a large sample of different participants in the second phase to avoid questions of bias in the quantitative strand.
- Procedures should be undertaken to ensure that the scores developed on the instrument are valid and reliable.

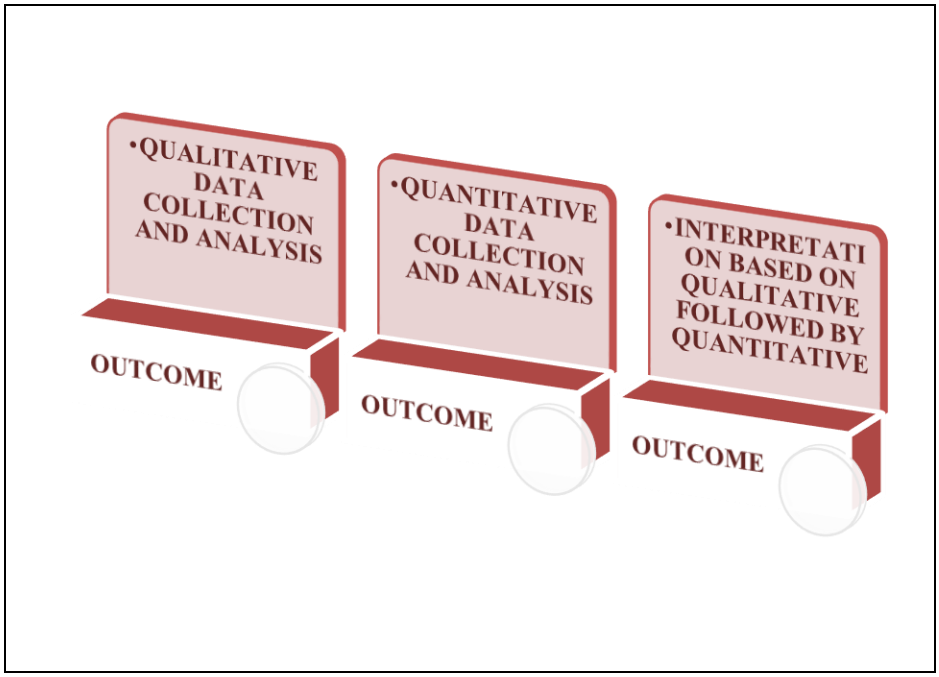


Diagram 3.6: Showing the Sequential Exploratory Strategy

Source: (Investigator Self Made)

3.6.3 Sequential Transformative Strategy:

This typology consists of two different phases of data collection, one following the other as in the above two strategically types described before. The sequential transformative strategy is a dual phase design (either quantitative or qualitative) followed by second phase (either qualitative or quantitative) that builds on earlier phase.

Here researchers have a choice to use either method of the first phase and the weight can be given to either or distributed evenly to both the phases. As in case of sequential design, mixing is connected in all. So like the other two phases this typology is also not free from theoretical perspective to guide the study. While using both the phases in sequential transformative

researchers are able to put voice to divergent perspectives, to better advocate for participants or to better understand a phenomenon or process which is being changing as a result of being studied .So this way it allows theoretical perspective to quick study and determines the order of data collection and then results are integrated at interpretation.

3.6.3.1 Strength:

- While using the distinct phases it facilitates its implementation, description and sharing of results.
- It gives voice to diverse perspectives and to advocate for participation or to better understand a phenomenon or process that is changing as a result of being studied.

3.6.3.2 Weakness:

- It requires time to complete two data collection phases.
- There is little guidance on how to use the transformative vision to guide the method.

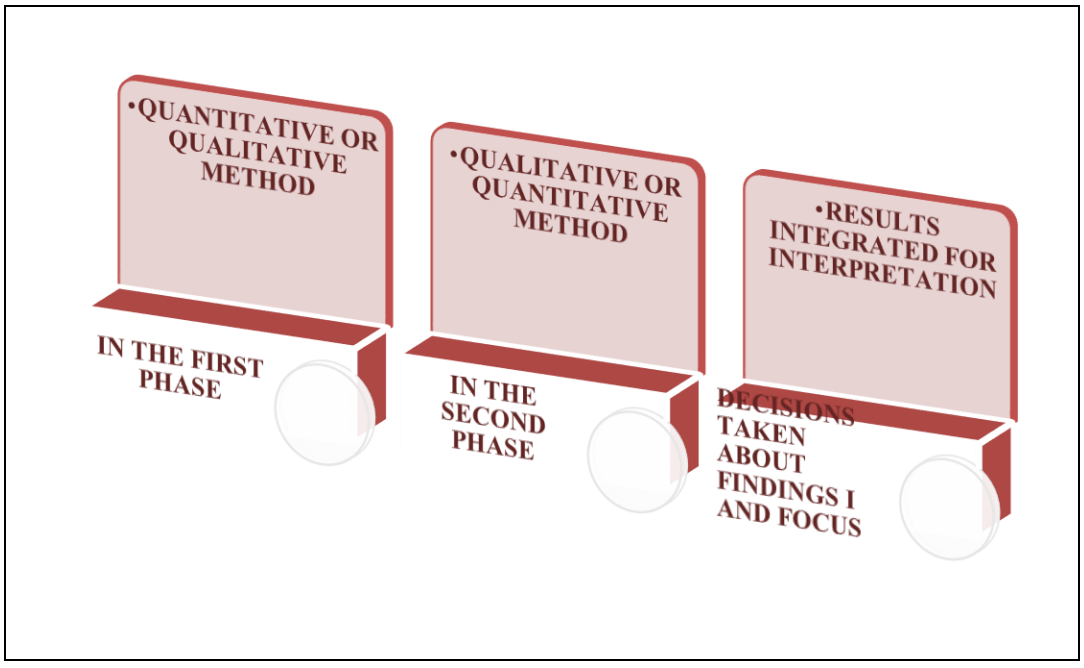


Diagram 3.7: Showing the Sequential Transformative Strategy

Source: Investigator Self Made

3.7 Concurrent Triangulation Strategy:

This typology is the most common and familiar in compares to other major typologies. Here researcher involves himself in both quantitative and qualitative data concurrently and then he compares the collected database to determine if there is convergence, differences or some combination.

Some authors refer this comparison as **Confirmation, Cross- Validation or Corroboration**.

This typology separately uses qualitative and quantitative method as to offset the inherent weakness within one method with the strength of the other. I is concurrent because both quantitative and qualitative data collection takes place in single phase of the research.

Definitely equal weight is given to both the methods but in the practical phase often priority is given on one over the other.

So the mixing during this approach is generally found in an interpretation or discussion section, in order to amalgamate the data (transforming one types of data into another one so that they can be easily compared) or to integrate, compare the results of two sets of database side by side in a discussion.

This side by side integration is often published in mixed method studies in which discussion section first provide quantitative statistical result followed by qualitative quotes that supports or negates the quantitative results.

For example, researcher conducted survey and undertaken interview to collect data simultaneously.

3.7.1 Strength:

- Concurrent triangulation method supports the validation and substantiated findings.
- It requires very short time for data collection as because both quantitative and qualitative data are collected simultaneously in the same stage.
- It can expand the quantitative data through collection of open ended qualitative data.

3.7.2 Limitations:

- It requires great expertise on the part of researcher to collect data and adequately to study the phenomena with two separate methods.
- It may also establish a problem for a researcher to compare the results of two analysis using data of different forms.
- Researcher may not have clarity about how to solve the discrepancies arises while comparing the results although the procedures are emerging the literature such as conducting additional data collection to resolve discrepancies, revisiting the original database, gaining new insight from the disparity of data or developing new projects that addresses different discrepancies.

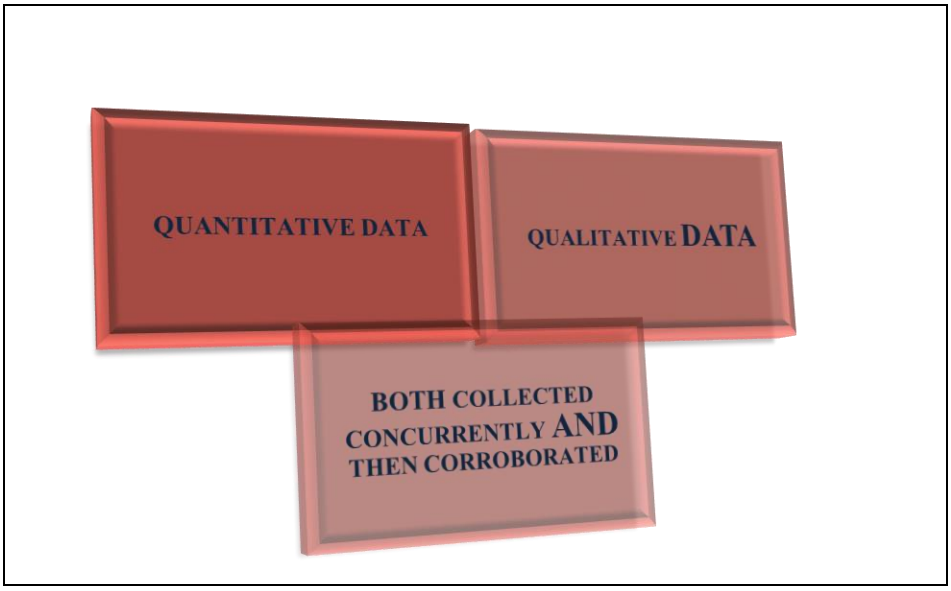


Diagram 3.8: Showing the Convergent Triangulation Strategy.

Source: Investigator Self Made

3.8 Concurrent Embedded Strategy:

Like the Concurrent Triangulation approach, the Concurrent Embedded Strategy of mixed method research can be identified by its use of one data collection phase during which both qualitative and quantitative data are collected simultaneously. In this method one is embedded within the other. Here n this typology priority is given to primary data collection approach with less emphasis placed on the nested approach and data are mixed during the analysis phase. A theoretical perspective may or may not guide the design. The primary purpose of it is to gain a broader perspective than would be gained from using only the predominant data collection method.

It is also used to address different research questions or accumulate information from different groups or levels within an organization. Here, researcher combines the collection and analysis of both quantitative and qualitative data within a traditional quantitative research design or qualitative research design **(Caracelli & Greene, 1997; Greene, 2007)**.

The collection and analysis of the second data set may occur before, during, and/or after the implementation of the data collection and analysis procedures traditionally associated with the larger So, it is a one phase data collection in which priority is given to one approach that guides the project while the other approach is nested or embedded in the project to provide support or to devote additional source or arguments, through different questions is addresses.

3.8.1 Strength:

- The researchers are able to collect two types of data simultaneously, where advantages of both the methods can be gained.

- According to Morse, this method can enrich the description of the sample participants by embedding the qualitative design to some quantitative data.
- This typology can be employed when researcher have a choice to employ different methods for studying different groups or levels.
- Because the different methods are addressing different questions, this design fits a team approach well, where members on the team can focus their work on one of the questions based on their interests and expertise. • The focus on different questions means that the two types of results can be published separately.
- Tashakkori and Teddlie noted that this approach as a multi-level design.
- Lastly, one method could be used within the framework of the other method.

3.8.2 Weakness:

- The problem of this approach is that the data need to be transformed to allow the integration during the analysis which may lead to issue in resolving the discrepancies that occurs between different data types.
- The scope of literature is very narrow in this area for providing guide or assistance to the researcher.
- It can be difficult to integrate the results when the two methods are used to answer different research questions. However, unlike the convergent design, the intent of the embedded design is not to merge two different data sets collected to answer the same question.

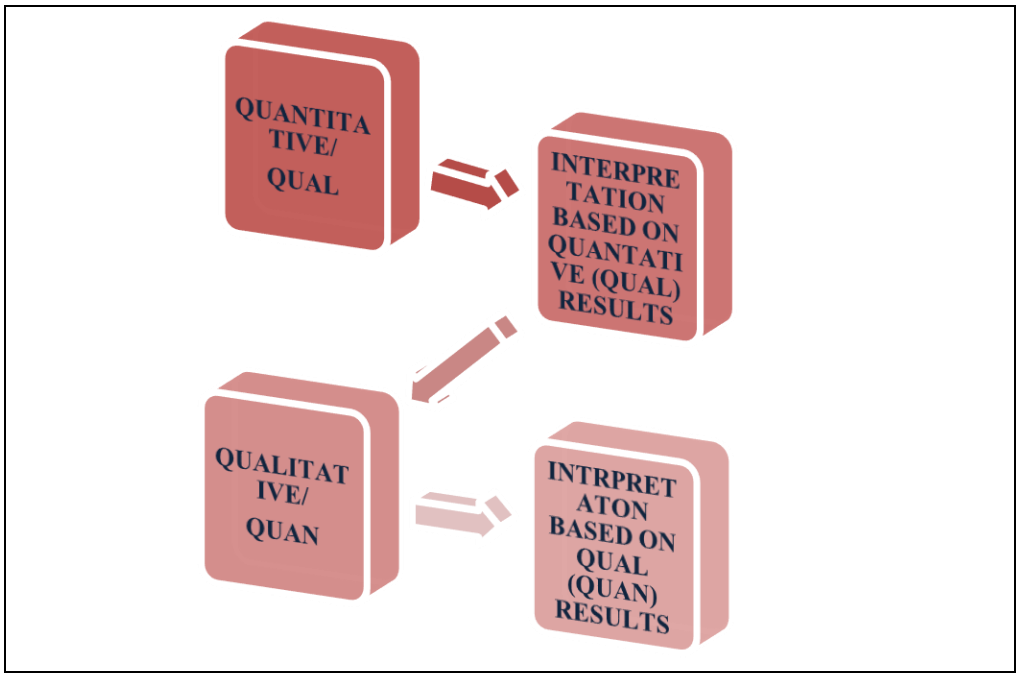


Diagram 9: Showing the Concurrent Embedded Strategy.

Source: Investigator Self Made

3.9 Concurrent Transformative Strategy:

This model is definitely supported by researcher use of a specific theoretical perspectives as well as concurrent collection of both qualitative and quantitative data.

It is based on the ideologies of critical theory, participatory research, conceptual or theoretical framework.

The choice of concurrent model whether to use it as triangulation or embedded typologies is made to facilitate this perspective.

So both qualitative and quantitative data are collected which are guided by theoretical perspectives which guides methodological choices and the purpose is to evaluate the perspectives at different levels of analysis.

For example, the design may have one method embedded in other so that diverse participants are given a voice in the change process of organization.

It may involves the triangulation of qualitative and quantitative data to best coverage information to provide evidences for an inequality of policies in an organization.

So it takes the design features of triangulation or embedded approaches.

The merging of data would be through the mixing or embedding the data, because the current transformation model shares features of both triangulation and embedded approaches. It also shares their specific strength and weakness.

3.9.1 Strength:

- The researcher gets a chance to address the issues for social justice and to bring changes in the society.
- In this strategy the needs and demands of marginalized or unprivileged groups were taken In to consideration.
- Participants play an active as well as participatory role.
- The researcher is able to use a collection of methods that produces results that are both useful to community members and viewed as credible to stakeholders and policy makers.

3.9.2 Weakness:

- There is still little guidance in the literature to assist researchers with implementing mixed methods in a transformative way. One way to proceed is to review published mixed methods studies that employ a transformative lens **(Sweetman, Badiee, & Creswell, 2010)**.
- The researcher may need to justify the use of the transformative approach. This can be done by explicitly discussing the philosophical and theoretical foundations as part of the study proposal and report.

- The researcher must develop trust with participants and be able to conduct the research in a culturally sensitive way.

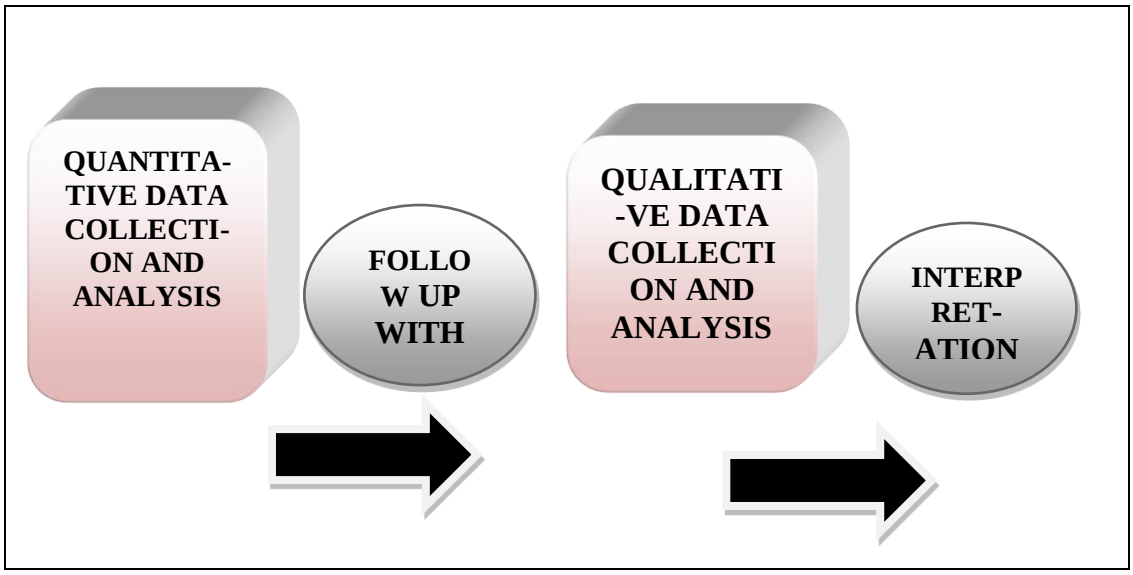


Diagram 3.10: Showing the Concurrent Transformative Strategy.

Source: https://www.sagepub.com/sites/default/files/upm-binaries/35066_Chapter3.pdf

3.10 The Multiphase Design:

The Multiphase mixed typology is the complex and complicated design as because it has been built on the bedrock of above all basic designs like the convergent, explanatory, exploratory embedded where the teams of researcher examine the problem through a series of phases or separate studies that are sequentially aligned with each new approach building on what was learned previously to address a central program objective.

Today, multiphase designs combine sequential and concurrent aspects and are most common in large funded studies that have numerous questions being investigated to advance one programmatic objective.

Two primary examples of this design would be a multi-project funded mixed methods project involving numerous investigators and researchers for U.S. federal funding (e.g., a National Institutes of Health [NIH] or National Science Foundation [NSF] project) or a statewide evaluation study involving multiple levels of data collection and analysis as well as multiple studies.

It provides an overarching methodological framework to a multiyear project that calls for multiple phases to develop an overall program of research, or evaluation. For example, in the context of program evaluation, these multiple phases may be tied to phases for needs assessment, program development, and program evaluation testing.

3.10.1 Strength:

- The multiphase design incorporates the flexibility needed to utilize the mixed methods design elements required to address a set of interconnected research questions.
- Researchers can publish the results from individual studies while at the same time still contributing to the overall evaluation or research program.
- The design fits the typical program evaluation and development approach well.
- The researcher can use this design to provide an overall framework for conducting multiple iterative studies over multiple years.

3.10.2 Weakness:

- The researcher must anticipate the challenges generally associated with individual concurrent and sequential approaches within individual or subsequent phases.
- The researcher needs sufficient resources, time, and effort to successfully implement several phases over multiple years.
- The researcher needs to effectively collaborate with a team of researchers over the scope of the project, while also accommodating the potential addition and loss of team members.
- The researcher needs to consider how to meaningfully connect the individual studies in addition to mixing quantitative and qualitative strands within phases.
- Due to the practical focus of many multiphase designs for program development, the investigator needs to consider how to translate research findings into practice through developing materials and programs.
- The researcher may need to submit new or modified protocols to the IRB for each phase of the project.[8]

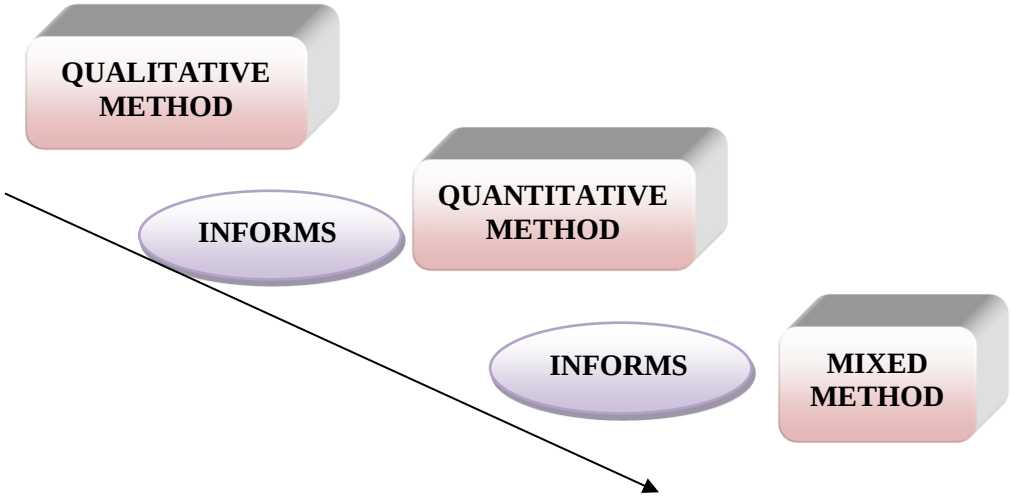


Diagram 3.10: Showing the Multiphase Design.

Source: https://www.sagepub.com/sites/default/files/upm-binaries/35066_Chapter3.pdf.

3.11 Steps for Conducting Mixed Research Method:

3.11.1 Determine A Mixed Method Study That Is Feasible:

Researcher must select the topic that is suitable to undertake the design the mixed method. Then he must access to both qualitative and quantitative data, background and resources.

3.11.2 Identifying a Rationale for a Mixed Method Study:

In this stage the researcher need to provide the rationale for selecting the mixed method design including both qualitative and quantitative approach.

With it he must also explicitly discuss the reasons for collecting the qualitative and quantitative data, including it early in the research plan.

3.11.3 Identifying the Data Collection Strategy:

Now researcher will give priority to quantitative and qualitative data, the sequence of data collection, the specific forms of qualitative and quantitative data need to be collected either through qualitative instruments (interview, observation, document etc.) or quantitative instruments (survey, checklist etc).

3.11.4 Develop Qualitative, Quantitative or Mixed Method Questions:

Researcher now need to identify the questions prior to study or during the study.

Researchers need to establish both exploratory and analytic variable questions. Questions will be developed depend on the type of design.

3.11.5 Collection of Quantitative and Qualitative Data:

The sequence of data collection will definitely depend on the type of design that has been employed by the researcher. After that presentation of data or information need to be sequentially arranged by the researcher.

3.11.6 Analyzing Data Separately or Concurrently:

Now in this stage data will be analysed by the researcher pivotally relate to the specific type of design that will be used.

3.11.7 Writing a Research Report:

Researcher will write the report in two phases, which integrates the quantitative and qualitative phases or diagram of the design.[9]

3.12. Conclusion:

Mixed method research actually has a long history in research practice. Generally contingency theory is recommended for research approach selection which accepts the quantitative, qualitative and mixed research are all superior under the different circumstances and it is the researcher's work to examine the specific contingencies and make the decisions about which research approach or combination of approaches should be used in specific study. It is a philosophical assumption as well as a method of inquiry.

3.13. References:

1. **Guest, Greg. (2013)**. Describing mixed methods research: An alternative to typologies. ***Journal of Mixed Methods Research*** 7:141–151.
2. **Hesse Biber, Sharlene. (2010**). Qualitative approaches to mixed methods practice. Qualitative Inquiry 16:455–468.
3. **Johnson, R. Burke. (2017)**. Dialectical pluralism: A Meta paradigm whose time has come. ***Journal of Mixed Methods Research*** 11:156–173.
4. **Bryman, Alan. (2006**). integrating quantitative and qualitative research: How is it done? Qualitative Research 6:97–113.
5. **Bazely, P. (2004**). Issues in mixing qualitative and quantitative approaches to research. In. R. Buber, J. Gadner, & L. Richards (Eds.) Applying qualitative methods to marketing management research. ***UK: Palgrave Macmillan, (pp. 141- 156).***
6. **Clark, V. & Creswell, J. (2008).** The mixed methods reader. Los Angeles: SAGE.
7. **Creswell, J. (2003).** Research design: A qualitative, quantitative, and mixed method approaches (2nd Ed.). Thousand Oaks, CA: Sage.
8. **Gay, L. Mills, G. & Airasian, P. (2008).** Educational research: competencies for analysis and application (9th Ed.). Upper Saddle River, NJ: Merrill.
9. **Johnson, R. B. Onwuegbuzie, A. J. (2004).** Mixed-methods research: a research paradigm whose time has come. Educational Researcher, 33(7), 14-26.
10. **Tashakkori, A. Teddlie, C. (2008).** Introduction to mixed method and mixed model studies in the social and behavioral science. In V.L. Plano-Clark & J. W. Creswell (Eds.), the mixed methods reader, (pp. 7-26).
11. **Erzberger, Christian. Gerald, Prein. (1997**). Triangulation: Validity and empirically based hypothesis construction. Quality and Quantity 31:141–154.
12. **Greene, Jennifer C. (2007).** Mixed methods in social inquiry. San Francisco: Jossey-Bass.
13. **Yanchar, SC. Williams, DD**. Reconsidering the compatibility thesis and eclecticism: Five proposed guidelines for method use. Educational Researcher. 2006; 35(9):3–12. Doi: 10.3102/0013189X035009003.
14. **Morse, Janice M. (1991).** Approaches to qualitative-quantitative methodological triangulation. Nursing Research 40:120–123.
15. **Morse, Janice M., and Linda Niehaus. (2009)**. Mixed method design: Principles and procedures. Walnut Creek: Left Coast Press.
16. **Roth, Louise Marie. (2006**). selling women short: Gender and money on Wall Street. Princeton: Princeton University Press.
17. **Schoonenboom, Judith. (2016**). the multilevel mixed intact group analysis: A mixed method to seek, detect, describe and explain differences between intact groups. Journal of Mixed Methods Research 10:129–146.

ISBN: 978-93-90847-07-5

Chapter - 4 : Experimental Research Designs: A Review

Deepthi Karunakaran

Research Scholar, Department of Education, Mother Teresa Women's University, Kodaikanal, Tamil Nadu.

&

Dr. P. B. Beulahbel Bency

Assistant Professor, Department of Education, Mother Teresa Women's University, Kodaikanal, Tamil Nadu.

Abstract:

Research designs are the frame works of a research which provides insight about how to conduct research using a certain methodology. Research designs helps in the decision regarding what, where, when, how much, by what means concerning an inquiry or a research study. Experimental research is a study that strictly adheres to a scientific research design. This article focuses on the importance of research designs in experimental research and its various types etc.

Keywords: Research Design, Experimental Research, Scientific Research Design and Inquiry

4.1 Introduction:

Research in common parlance refers to a search for knowledge. Research can be defined as a scientific and systematic search for pertinent information on a specific topic. According to Merriam- Webster Dictionary, research is a careful or diligent search and it is the investigation or experimentation aimed at the discovery and interpretation of facts, revision of accepted theories or laws in the light of new facts, or practical application of such new or revised theories or laws. Research methodology is a means to reach the findings of a research.

It is the specific procedures or techniques used to identify select, process and analyze information about a topic. The methodology section of any research answers two main questions: "How was the data collected or generated? How was it analyzed?" Thus the purpose of the research methodology is to satisfy the research plan.

4.2 Research Design:

Research design is the general plan to answer a research question. As a systematic approach to conducting a scientific inquiry, it brings together several components, strategies and methods to collect data and analyze it (Saunders, et al, 2009). It is a framework that includes the methods and procedures to collect, analyze and interpret data. Research design also defines all other constituent parts of a study, such as variables, hypotheses, experiments, methodology and statistical analysis (Creswell et al, 2018).

An excellent research design has the one and only purpose to make the data address the research problem as clearly, as accurately and as unbiased as possible, whereas the Research Methodology is the path through which researcher need to conduct their research. Research is an art of scientific investigation (Patel & Patel, 2019). Research design is the frame work of research methods and techniques chosen by a researcher. The design allows researchers to hone in on research methods that are suitable for the subject matter and set up their studies for success.

4.2.1 Significance of Research Design:

Research Design carries an important influence on the reliability of the results attained. It therefore provides a solid base for the whole research. It is needed and significant due to the fact that it allows for the smooth working of the research operations.

This makes the research effective by providing maximum information with minimum of effort, money and time. Research design can be compared to a blueprint that is meant for data collection and analysis of the research study. This has a great significance and impact on the reliability of the results achieved and as such constitutes the firm base for the research work.

4.2.2 Key Characteristics of a Research Design:

There are four key characteristics of a research design. They are:

- ***Neutrality:*** The results projected in the research design should be free from bias and neutral.
- ***Reliability:*** The research design should indicate how to form research questions to ensure the consistency of the results.
- ***Validity:*** Even though there are multiple measuring tools, the tools shall help the researcher in gauging results according to the objectives of the research.
- ***Generalization:*** The outcome of the research should be applicable to the population with similar accuracy.

4.2.3 Types of Research Design:

There are 5 types of research designs:

- Descriptive research design
- Experimental research design
- Correlational research design
- Diagnostic research design
- Explanatory research design

4.3 Experimental Research Design:

Experimental Research Design is concerned with constructing research that is high in internal (causal) validity. This validity in turn concerns the accuracy of statements regarding cause and effect relationships. The experimental research designs have 3 components:

- **Manipulation:** The ability to influence or direct the independent variable.
- **Control:** The ability to direct or influence important extraneous variables and study measurements.
- **Randomization:** Unbiased or random subject assignment to each group.

4.3.1 Types of Experimental Research Design:

There are 3 primary types of experimental designs:

- Pre - experimental
- True - experimental
- Quasi - experimental

A. Pre - Experimental Designs:

Out of the three experimental research designs, this is the effective one. It is characterized by the lack of a control group or a failure to provide for the equivalence of a control group. Three types of research designs come under this category. They are:

- ***The One-Shot Case Study:*** In this the result of the treatment are compared with a general expectation of what would have happened if the treatment had not been applied (Best & Kalm, 2006). This design provides the weakest basis for generalization.
- ***The One-Group, Pretest:*** *Posttest Design*: This design provides some improvement over the One-Short Case Study Design for the effects of the treatment are judged by the difference between the pretest and the post test scores. However, no comparison with a control group is provided.
- ***The Static-Group Comparison Design:*** This design compares the status of a group that has received an experimental treatment with one that has not. There is no provision for establishing the equivalence of the experimental and control groups which is a limitation of this design.

B. True - Experimental Designs:

In a true experiment, the equivalence of the experimental and control groups is provided by random assignment of subjects to experimental and control treatments. It is the strongest type of design. In this type of design too, there are three designs such as:

- ***The Posttest - Only, Equivalent Group Design:*** This design is one of the most effective in minimizing the threats to experimental validity. In this experimental and control groups are equated by random assignment. After completing the experimental period the difference between the mean test scores of the experimental and control groups is subjected to a test of statistical significance.
- ***The Pretest - Posttest Equivalent Groups Design:*** This method is almost equivalent to the Post – test only Equivalent Groups Design but the pretests are administered before the application of the experimental and control treatments and posttest at the end of the treatment period. Pretest scores can be used in analysis of covariance to statistically control for any difference between the groups at the beginning of the study.

This is a strong design, but there may be a possibility of the influence of the interaction effect of testing with the experiment variable (Best & Kahn, 2006).

- ***The Solomon Four - Groups Design:*** This designs is a combination of the two group's designs, the posttest only and the pretest - posttest. This design permits the evaluation of the testing of the effects of testing, history and maturation. Analysis of variance is used to compare the four posttest scores.

C. Quasi - Experimental Designs:

This is similar to the Pretest - Posttest Equivalent group design, but differs because random assignment to experimental and control treatments has not been applied. Hence the equivalence of the groups is not assured. Of the many quasi - experimental designs, the often used design is:

D. The Pretest – Posttest Nonequivalent Groups Design:

This design is often used to classroom experiments, when experimental and the control groups are natural intact classes which may be similar. Analysis of covariance is used with the pretest as the covariate.

4.3.2 Advantages & Disadvantages of an Experimental Research Design:

This is the most powerful design to establish causal relationship between independent and dependent variable. It creates conditions in a short period of time that may take years to occur naturally. These are conducted in laboratory, experimental unit or in specialized research setting.

Whereas, the experimental research designs have many disadvantages too such as; it cannot be replicated in studies conducted in humans due to ethical problems. Many of the human variables neither have valid measurable criteria nor instruments to measure. Studies conducted in community are difficult to control the extraneous variable. It is also very difficult to get cooperation for treatment / intervention (Kavitha, 2014).

4.4 Conclusion:

Experimental research design is the blue print of the procedures that enables the researcher to test hypotheses by reaching valid conclusions about relationships between independent and dependent variable. This is needed because it facilitates the smooth sailing of the various research operations. Hence the research designs provide a framework to the research and combine various components of research in a reasonably logical manner so that the research problem is efficiently handled.

4.5 References:

1. Best, J.W. & Kahn, J.V. (2006). Research in Education. Pearson Prentice Hall, Delhi.
2. Creswell, J.W., & Creswell, J.D. (2018). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 5th ed. Thousand Oaks, CA: Sage. Google Books.

3. Kavitha, D. (2014). Experimental designs completely randomized design, Randomized Block design, Latin square design, and other designs. Retrieved from slideshare.net/ Kavitha Prabhakar 37 / experimental design.
4. Patel, M. & Patel, N. (2019). Exploring Research Methodology: Review Article: International Journal of Research and Review. Vol.6 Issue.3. E-ISSN: 2349-9788.
5. Question pro.com (2020). Research design: Definition, Characteristics and Types.
6. Saunders, et al. (2009). Research Methods for Business Students. (5^{th}ed.). London, UK: Pearson Education.
7. Universalteacher.com (2020). Importance of Research Design.
8. Verma, S. (2015). Research Design, retrieved from slideshare.net.

ISBN: 978-93-90847-07-5

Chapter - 5 : Research Report Writing and Research Publication for Engineers

Divya Bharati

Asst. Professor, Ballari Institute of Technology and Management, Ballari.

&

Dr. G. P. Dinesh

Professor, Vijayanagara Sri Krishna Deveraya University, Ballari.

5.1. Introduction:

Report writing is formal writing. Many engineers have trouble telling informal writing apart from formal writing. They report to informal writing, since it is easier and more familiar characteristics of informal writing include the use of colloquialisms and jargon, writing in the first person or making 'I' statements, making direct personal statements, and imprecise word choices.

Informal writing is fine for dairy entries, blogs, personal writing letters or emails to friends. However, writing working on assignments and essays for colleges, scientific papers, research papers, conference and seminars presentations and business proposals generally employ a more formal style.

5.2 Report Writing:

5.2.1 The Characteristics of Report Writing Include:

- A formal tone
- Use of the third person perspectives
- Clear focus on the issue
- Precise word choice
- Avoid jargon, slang and abbreviations

5.2.2 Key Features of Any Report Writing Are:

- Thinking precedes writing. Strong report writing begins with solid planning.
- Excellent grammar and constant styling approach.

5.2.3 Characteristics of a High-Quality Report Writing:

- The Theme of the report clearly reflects the focus and the argument.
- A significant and substantial problem has been selected for investigation.
- There is an early statement of the research report aims.
- The report presents a considerable advance on existing knowledge.

- The report demonstrates a systematic pursuit of a consistent line of inquiry
- It is well-planned and executed, with each section clearly building on the last
- There is clear signposting and linking between paragraphs, sections, and chapters. It consistently reminds the reader of the purpose, argument, or overall thrust of the report.
- The literature review is critical and evaluative, and sets forth an argument for why and how the study should be conducted.
- The discussion of the rationale for selecting a methodology and method including up-to-date methodological literature is balanced. The ground-setting is sophisticated and appropriate including exposition of underlying assumptions, and relevance to the research aim.
- The research design is appropriate and allows the questions to be answered.
- There is a meticulous account of the procedure.
- A rich variety of evidence is employed to develop a balanced argument.
- Advanced analytical skills are used to demonstrate a deep understanding of the problem, a clear chain of evidence is laid down.
- The discussion is disciplined and not excessively speculative.
- Conclusions are well drawn and convincing (they relate the outcomes back to the research aims): clear and strong knowledge claims are made about the exact contributions of the thesis.
- Key concepts or variables are clearly defined and consistently used throughout.
- Written expression is elegant, precise, and economical.
- There is evidence of systematic proofreading and error correction.

5.3 Discussion:

5.3.1 Consult:

- Consult with your professor and colleagues about the most appropriate journal where you can publish your research.
- Match your topic to the journal, or vice versa.
- Download the guidelines for authors- these will tell you about the style and structure of your paper.
- Choose frequently cited papers in the journal to see how other authors construct their argumentation, and note down ways in which your research is different and innovative with respect to theirs.
- Choose one paper as a model onto which to map your research, imitating the style and organization. This model should be written by a native English speaker.
- Note down useful/ standard phrases from your model paper which you can then use in your own paper.
- Decide on the best order to write the various sections of your paper. It is generally best to start with a very rough draft of Abstract, and then whichever section is clearest in your head (generally the Materials and Methods).
- Consider having separate documents for each section. This enables you to work on several sections at the same time.
- Make sure your unique contribution to your community is very clear in every section, not just in the Abstract.
- Write in a way that even a non-expert can understand.

- Referees work for free and often outside working hours – never submit a carelessly written manuscript.
- Access referees report forms to understand the ways that referees will evaluate your work.
- Write directly in English and use every opportunity for improving your writing skills.
- Use online resources.

5.3.2 Language:

- Basic English word order is: (1) subject, (2) verb, (3) direct object, (4) indirect object. Keep these four elements in this order and as close to each other as possible.
- If you have a choice of subjects, choose the one that is the most relevant and leads to the shortest construction.
- Avoid delaying the subject. So don't begin a sentence with the impersonal it.
- Avoid inserting parenthetical information between the subject and the verb.
- Most adverbs are located just before the main verb, and before the second auxiliary verb when there are two auxiliaries.
- If possible, delay adverbs until later in the sentence. The main exceptions to this rule are adverbs of contrast and those that enumerate points.
- Put adjectives before the noun they describe or use a relative clause. Do not insert an adjective between two nouns or before the wrong noun.
- Do not indiscriminately put nouns in a string.
- Avoid ambiguous word order.

5.3.3 Reader:

To increase readability:

- Don't separate the subject from its verb using more than 8-10 words.
- Avoid adding extra information to the end of the main clause, if the main clause is already about 15-20 words long.
- Check to make sure that a sentence has a maximum of 30 words, and don't use more than three or four 30- word sentences in the whole paper.
- Consider beginning a new sentence if the original sentence is long and contains one or more of the following (or equivalents): and, which, a link word, the -ing from, in order to.
- Maximize the use of periods (.). Use the minimum number of commas (,), avoid semicolons (;) and parentheses.
- Don't worry about repeating key words. If diving up a long sentence into shorter sentences means that you have to repeat key words, this is not a problem. In fact this repetition will increase the clarity of your writing.
- Always think about your readers- order the information you give them in the most logical way and in the simplest form.
- Begin each paragraph with a topic sentence, then use the rest of the paragraph to develop this topic. If appropriate have a short concluding sentence at the end of the paragraph.
- Decide whether to begin a new section with a short summary, or whether to go directly to the main points.

- Put the topic as the subject of the paragraph or sentence, then give known information (context, background) followed by new information. Consider not giving the known information if it will be obvious for your readers.
- Move from the general to the increasingly specific, do not mix the two.
- Always progress in the most logical and consistent order, do not go backwards and forwards.
- Don't force readers to change their perspective: put negations and qualifying phrases at or near the beginning of a sentence.
- Break up long paragraphs and begin a new paragraph when you talk about your study and your key findings.
- Avoid redundancy in the final paragraph of a section.

5.3.4 Edit:

- You can be more concise by:
- Deleting any words that are not 100% necessary.
- Finding ways of expressing the same concept with fewer words
- Using verbs rather than nouns
- Choosing the shortest words and expressions
- Avoiding impersonal phrases that begin it is

A frequent result of reducing the overall number of words is that the subject of the sentence tends to be shifted closer to the beginning of the sentence. This means that the reader gets a much quicker picture of the topic of the sentence.

Also, if you use the minimum number of words the importance of what you are saying will stand out more clearly for the reader.

These rules in this chapter are designed to help you write in a more concise way. However, it is also important to vary the way you write. It is perfectly acceptable to write a long phrase or sentence, or a complicated construction, provided that you only do this occasionally.

5.3.5 Write:

Your writing will be much clearer if you take into account the following:

- Which is used for adding information about the preceding noun that defines the preceding noun.
- Which, that and who should only refer to the noun immediately preceding them.
- The -ing from (gerund) has no subject. Make sure it is clear what the subject of the -ing form is.
- Clarify whether something is a consequence of doing something or a means to so something by using thus (consequence) and by (means) before the -ing form.
- Use the definite article (the) before a noun only if you refer to a specific example of that noun. If you are giving a generic idea, do not use the article.
- Learn the most frequent uncountable nouns and false friends in your field.

- Be very careful when you use pronouns (this, that, them, it etc.) – make sure it is clear what they refer to and don't be afraid of repeating the same word many times (if this will improve clarity).
- Avoid using the former … the latter, simply repeat the related noun.
- If necessary, specify exact locations, when using above and below.
- Use respectively when it is not 100% clear how items are related to each other.
- Be careful of punctuation with which and - punctuation must help the reader understand the relationships between the various parts of the sentence.
- Don't confuse both …and (inclusive) with either … or (exclusive); and i.e. (definitions) and e.g. (examples)
- Never use synonyms for key words, only for generic verbs and adjectives
- Use the most precise word possible.

5.3.6 Journal:

- Follow the journal's instructions regarding whether you can use we/I or if you have to use the passive at all times.
- You may have the impressions that the passive form is constructed to be more elegant in scientific papers. Whether this impression is true or not, be aware that the passive inevitably creates problems for your readers because it may be difficult for them to know immediately and with certainty whether you or another author made a particular finding.
- Do not rely on a reference to a figure or a table, or a reference to the bibliography to distinguish your new data from those in the literature. Make sure the reference clearly indicates it is another author's work and not a previous paper by you.
- Be aware that if you make mistakes in the usage of tenses when you are comparing your work other authors' work, you could really confuse your readers. Make sure you consistently use the correct tense and remember that in English there is a real difference between the SIMPLE PAST (finished actions with time indications) and the PRESENT PERFECT (past to present actions, finished actions with no time indication)
- Avoid using we when it is not really necessary, i.e. to explain your train of thoughts.
- Help readers to distinguish between your work and others by using a series of short paragraphs, rather than one long paragraph.
- If you mention another author's paper, make sure that the reader understands why you are mentioning that paper and how it relates to your own work.

5.3.7 Layout:

- Be aware of how the layout of your paper can affect where readers focus their eyes - break up long blocks of text using shorter paragraphs and figures/ tables.
- Begin a new paragraph when highlighting something important.
- Use shorter sentences and paragraphs to make your key points.
- Use more dynamic language- make sure the reader understands immediately that you are about to say something important.
- Don't just tell the readers that something is important – show them.
- Tell your readers the implications of your findings.
- Talk about your weaknesses not just your strengths; do not make the referees suspect any bias in your work.

5.3.8 Challenges:

Anticipate possible opposition by your referees and readers by not saying things too assertively or directly.

In practical terms, it is not difficult to insert ‘we believe’ and ‘might’ when describing key findings that could be interpreted in different ways.

And if by using these hedging devices you increase your chances of having your paper accepted in a journal located in the USA or UK, then you should use them!

- Tone down verbs, adjectives, adverbs ad your general level of certainty.
- Be aware that the ways you express uncertainty may simply not translate into English.
- Provide alternative interpretations of your data.
- Tell the reader from which standpoint you want them to interpret or judge your data.
- Use impersonal forms to distance yourself when interpreting your findings.
- Save your face by writing in an impersonal fashion.
- Try to put the work of authors in a positive light. If appropriate say their work is open to another interpretation (i.e. yours)
- Don’t over hedge.
- Consider getting help from a native speaker when hedging your claims.

5.4 Questions to Ask:

5.4.1 How can ONE Assess the Quality of Report Ttitle?

- You need to check that your title is:
- In correct English – in terms of syntax, vocabulary, spelling and capitalization
- Understandable (no strings of nouns)
- Eye-catching and dynamic (through effective use of vocabulary and even punctuation's)
- Sufficiently and appropriately specific
- Reflects the content of your paper
- Expressed in a form this is acceptable for a journal
- You can check the syntax and the level of understandability by consulting with a native speaker.
- Generally speaking titles that contain at least one verb and one or more prepositions tend to be much easier to understand
- You can check the vocabulary and spelling using Google Scholar. Remember that an automatic spell check is not enough
- The best way to decide whether it is eye-catching and sufficiently specific is to prepare several titles (including ones in two parts and in the form of a question) with various levels of specificity and ask colleagues to choose their favorite.
- Unless you get someone to read whole paper for you, you are probably the best judge of whether your title reflects the actual content of your paper.
- If it doesn’t the referees will probably tell you.

5.4.2 How can ONE Assess the Quality of Abstract?

To make a self-assessment of your Abstract, you can ask yourself the following questions.

- Have I followed the journal's instructions to authors? Have I followed the right structure (i.e. structured, unstructured) and style (we vs. passive)?
- Have I covered the relevant points from those below?
- Background/context
- Research problem/ aim-the gap I plan to fill
- Methods
- Results
- Implications and / or conclusion
- Have I chosen my keywords carefully so that readers can locate my Abstract?
- Whenever I have given my readers information, will it be 100% clear to them why they are being given this information? (You know why, but they don't)
- Can I make my Abstract less redundant? If I tried to reduce it by 25% would I really lose any key content?
- Have I used tenses correctly? PRESENT SIMPLE (established knowledge), PRESENT PERFECT (past to present background information), PAST SIMPLE (my contribution)

5.4.3 How can ONE Assess the Quality of Introduction Section?

- To make a self-assessment of your introduction, you can ask yourself the following questions.
- Is my research question clear?
- Does my Introduction act as a clear road map for understanding my paper?
- Is it sufficiently different from the Abstract, without any cut and pastes? (Some overlap is fine)
- Have I mentioned only what my readers specifically need to know and what I will subsequently refer to in the Discussion?
- Have I been as concise as possible?
- Have I used tenses correctly? PRESENT SIMPLE (general background context, description of what will be done in the paper), PRESENT PERFECT (past to present solutions), PAST SIMPLE (my contribution, though this may also be expressed using the PRESNET SIMPLE OT FUTURE SIMPEL)

5.4.4 How can ONE Assess the Quality of Literature Review?

To make a self-assessment of your Literature Review, you can ask yourself the following questions.

- Have I mentioned only what my readers specifically need to know and what I will subsequently refer to in the Discussion?
- Are the papers I have mentioned in a logical order? Is it clear why I have chosen these papers and not others?
- Have I selected a disproportionate number of papers from my own country?

- Have I followed my journal's instructions regarding how I make reference to the literature? Where possible have I done this in a variety of ways?
- Have I removed any redundancy when reporting the literature?
- Have I used tenses correctly? PRESENT SIMPLE (descriptions of established scientific fact), PRESENT PERFECT (at the beginning of review to give general overview; for past-to-present evolutions), and PAST SIMPLE (when specific dates are mentioned within a sentence; for the verbs that introduce an author's findings)

5.4.5 How can ONE Assess the Quality of Methodology Section?

To make a self-assessment of your Methods section, you can ask yourself the following questions.

- Have I really described my methods in a way that is easy for readers to follow and which would enable them to replicate my work? Have I ensured that I have covered every step? Is my structure clear and complete?
- Have I been as concise as possible? Have I used references to previous works rather than repeating description that readers could easily find elsewhere?
- Do the individual sentences in each paragraph contain too many, too few, or just the right manageable number of steps? Have I ensured that my sentence don't sound like lists?
- Have I thought about the way readers prefer to receive information? (No ambiguity, no back referencing, everything in chronological order, headings, bullets)?
- Have I checked my grammar (infinitive, gerund, allow, thus etc.) with regard to how I outline how and why I made certain choices?
- Have I checked my journal's guidelines on how to use numbers?
- Have I used tenses correctly? PAST SIMPLE (in the passive from to describe what I did), PRESENT SIMPLE (descriptions of established scientific fact)

5.4.6 How can ONE Assess the Quality of Findings Section?

To make a self-assessment of your Results section, you can ask yourself the following questions.

- Have I expressed myself as clearly as possible, so that the contribution that my results give stands out for the referees and readers?
- Have I limited myself to only reporting the key result or trends that each figure and table conveys, rather than reiterating each value?
- Have I avoided drawing conclusions? (This is only true when the Results is an independent section)
- Have I chosen the best format to present my data (e.g. figure or table)? Have I ensured that this is no redundancy between the various figures and tables?
- Have I ensured that my tables of results are comprehensive in the sense that they do not exclusively include points that prove my point?
- Have I mentioned only what my readers specifically need to know and what I will subsequently refer to in the Discussion?
- Have I mentioned any parts of my methodology (e.g. selection and sampling procedures) that could have affected my results?

- Have I used tenses correctly? PAST SIMPLE for your findings (in the passive form), PRESENT SIMPLE (descriptions of established scientific fact)

5.4.7 How Can ONE Assess the Quality of Report?

When you have finished writing your Discussion, it is a good idea to make sure you can honestly answer 'yes' to all the questions below. This will enable your peers to make a critical assessment with regard to the strengths and weaknesses of (a) how you carried out your research (b) and how you analysed your findings. The result will be that you will be seen as a credible researcher.

- Is my contribution to the knowledge gap clear? Have I underlined the significance of my findings?
- Have I explained what I believe to be new and important very clearly but without exaggerating? Have I ensured that I have not over-interpreted my results (i.e. attributed interpretations to them that cannot actually be supported?
- Have I truly interpreted my result, rather than just reiterating them? Have I shown the relationship (confirmation or rejection) between my results and my original hypothesis? Have I generated new theory rather than simply giving descriptions?
- Is there a good balance, rather than being a one-sided version? Have I really offered alternative explanations?
- Have I clearly distinguished fact from speculation? Will the reader easily be able to understand when I am merely suggesting a possible interpretation rather than providing conclusive evidence for something?
- Have I ensured that there is no bias in my research? (i.e., I have not hidden any of my data or any unexpected results, simply because they do not confirm what I hoping to find)
- Have I included those works in the literature that do not corroborate my findings? Likewise, have I avoided distorting the magnitude or direction of the data of the literature that I have selected? (I.e. I have made sure that I have not committed publication bias)
- Have I discussed my findings in the context of what I said in the introduction? Have I exploited my Review of the Literature?
- Have I integrated my results with previous research (including my own) in order to explain what I observed or found?
- Have my criticisms of the literature been justified and constructive?
- Have I ensured that I have not introduced any new findings (i.e., findings not mentioned in the results)?
- Are all the statement I have made in the text supported be the data contained in my figures and tables?
- Have I removed any trivial information? Have I been as concise as possible?

5.4.8 How can ONE assess the quality Conclusions Section?

To make a self-assessment of your Conclusions, you can ask yourself the following questions

- Is what I have written really a Conclusions section? (If it is more than 200-250 words, then it probably isn't – it needs to be much shorter)

- If the conclusions are included in the Discussion, have I clearly signaled to reader that I am about to discuss my conclusions (e.g. by writing in conclusion…)?
- Have I given a maximum of one line to comments related to descriptions of procedures, methodology, interviews etc.? (Generally such comments are not needed at all, unless the primary topic of your paper is the methodology itself)
- Have I avoided cut and pastes from earlier sections? Do my conclusions differ appropriately from my Abstract, introduction and final paragraph of my Discussion?
- Are my Conclusions interesting and relevant?
- Have I given my Conclusions as much impact as possible and have I avoided any redundant expressions?
- Have I avoided any unqualified statement and conclusions that are not completely supported?
- Is my work as complete as I say it is (i.e. I am not trying to get priority over other authors by claiming inferences that cannot really be drawn at this stage)
- Have I introduced new avenues of potential study or explained the potential impact of my conclusions? Have I ensured that I have only briefly described these future avenues rather than getting lost of detail?
- Are the possible applications I have suggested really feasible? Are my recommendations appropriate?
- Have I used tenses correctly? PRESENT PERFECT (to describe what you have done during the writing process), PAST SIMPLE (what you did in the lab, in the field, in your surveys etc.

5.5 Conclusion:

Report writing is quite formal in nature and the writer should plan effectively by consulting, using acceptable language, keeping readers in mind, editing unnecessary words and statements and doing proof reading before submitting the concerned authority.

Writer should keep in mind and answer the questions related to title, literature review, methodology, findings and conclusions clearly before submitting the research report to the journal for publication.

5.6 References:

1. Rowena Murray, How to Write a Thesis, 3e, McGraw Hill, Open University Press.
2. David Evans, Paul Gruba, Justin Zobel, How to Write a Better Thesis, 3e, Springr
3. Estelle M Philips and Derek S. Pugh, How to get a PhD, 4e, McGraw Hill, Open University Press
4. Guidelines for APA referencing and Essay Writing, Southern Institute of Technology, APA Style 7th Edition, revised 2020
5. Carol Ellison, Writing Research Papers, McGraw-Hills Concise Guide, McGraw Hill
6. Adrian Wall work, English for Writing research Papers, Springer

ISBN: 978-93-90847-07-5

Chapter - 6 : Literature Review

Dr. Prashantha Kumara T. M.

Assistant Professor, Department of Studies in Education, Vijayanagara
Sri KrishnaDeveraya University, Jnanasagara Campus.

6.1 Introduction:

Nowadays, post graduate students of education, research scholars and teacher educators required to undertake a literature review at some point, either as part of a course of study, as a key step in the research process, or as part of professional practices. The students and novice researchers often see literature review as a difficult undertaking.

It demands a complex range of skills, such as learning how to define topics for exploration, acquiring skills of literature searching and retrieval, developing the ability to analyse and synthesize data as well as becoming adept at writing and reporting. Often within a limited timescale. Literature review is the foundation of any research project.

It is as important as research tools and valuable in light of the knowledge explosion and the consequent impossibility of reading everything. The purpose of this module is to present a step-by-step guide to facilitate understanding the critical elements of the literature review process. While reference is made to different types of literature reviews, the focus is on the traditional or narrative review that is undertaken, usually either as an academic assignment or part of the research process.

6.2 What is Literature Review?

A literature review is an objective, thorough summary and critical analysis of the relevant available research and non- research literature on the topic being studied (Hart, 1998). It is an evaluative report of studies found in the literature related to a selected topic.

Literature review provides the reader with an up-to-date account of current literature on a topic and it forms the basis for justification for future research in the area. It should provide a theoretical basis for the research and help the researcher determine the nature of his/her own research.

It is important for a researcher to select the works that are central to the research topic rather than trying to collect a large number of works that are not closely connected to the topic. A good literature review gathers information about a particular topic from many sources.

It is well written and contains few, if any, personal biases. It should contain a clear search and selection strategy (Carnwell and Daly, 2001). Good structuring is essential to enhance the flow and readability of the review.

Accurate use of terminology is important and jargon should be kept to a minimum. Referencing should be accurate throughout (Coiling, 2003).

6.2.1 Reasons for Doing Literature Reviews:

A literature review goes beyond the search for information and includes the Identification and articulation of relationships between the literature and the field of research. While the form of the literature review may vary with different types of studies, the basic purposes remain constant. There are two major reasons for conducting a literature review: to conduct primary research or as an end in itself.

6.2.2 Literature Reviews for Planning Primary Research:

Almost every primary research study begins with a review of the literature. The purpose is to provide the reader with an overall framework where this piece of work fits in the "big picture" of what is known about a topic from previous research. Thus, the literature review serves to explain the topic of the research and to build a rationale for the problem that is studied and the need for additional research. As the foundation of any research project, the literature review should accomplish several important objectives.

- It sets the broad context of the study, clearly demarcates what is and what is not within the scope of the investigation, and justifies those decisions.
- It also situates an existing literature in a broader scholarly and historical context.
- It should not only report the claims made in the existing literature but also examine critically the research methods used to better understand whether the claims are warranted.
- It enables the researcher to distinguish what has been learned and accomplished in the area of study and what still needs to be learned and accomplished.
- It allows the researcher not only to summarize the existing literature but also to synthesize it in a way that permits a new perspective.

A good literature review is the basis of both theoretical and methodological sophistication, thereby improving the quality and usefulness of subsequent research. Researchers use the literature review to identify a rationale for the need for their own study. The following are some of the specific rationales for the research that might emerge from the literature review.

- The researcher may find a lack of consistency in reported results across the studies that have been chosen to review and undertake research to explore the basis of the inconsistency.
- The researcher may have uncovered a flaw in previous research based on its design, data collection instruments, sampling, or interpretation.
- The study may have been conducted on a different population than the one in which the researcher is interested, thus justifying the work with a different population.
- The researcher may document an on-going educational and propose studying the effect of an innovative intervention to try to correct that problem.
- Uncertainty about the interpretation of previous studies' findings may justify further research.

Besides understanding what is known about the research topic and provide a rationale for the study. The literature review is useful in the design of the study, especially for deciding sample size or data collection practices or instruments. It is useful for both quantitative and qualitative studies no matter what the researcher's paradigm.

The researcher who prepares a literature review should answer two critical questions: What are the strengths and weaknesses of the prior research? What is missing from the format body of scholarly literature that might be necessary in order to formulate an appropriate research focus and method of investigation?

Students receive different kinds of advice as to how much literature to review and at what stage of the research process this should occur. The number of studies that one actually cite In a literature review may be fairly limited because of space limitations (for authors who publish in journals) or because the review is considered a learning activity (In a course work). Typically, primary research articles published in journals contain 20 to 30 references to primary research. The number of citations may be quite limited for a course activity or more extensive if you are preparing a proposal for a thesis or dissertation. The exact number varies, depending on the purpose of the literature review and the available literature. The primary criterion for inclusion should be centrality to the topic, within the constraints imposed by instructors, advisers, or publishers. Use of the literature review to plan and conduct a study requires critical evaluation of the research that one reads.

This critical analysis forms the basis for the rationale or the choice of data collection procedures. An example of literature review for planning a research is available on http://www.physics.usyttedu.au/superitheses/PhO (Muller) pdf.

Table 6.1. Purpose of Literature Review

- Provide a context for the research.
- Justify the research.
- Ensure through research hasn't been done before (or that it is not just a "replication study")
- Show where the research fits into the existing body of knowledge.
- Enable the researcher to learn from previous theory on the subject.
- Illustrate how the subject has been studied previously.
- Highlight flaws in previous research.
- Outline gaps in previous research.
- Show that the work is adding to the understanding and knowledge of the field.
- Help refine, refocus or even change the topic.

6.2.3 Review of Literature as an End in Itself:

The review of literature can be seen as an end in itself, either to inform practice or to provide a comprehensive understanding about what is known about a topic. The process for conducting this type of literature review varies, depending on the purpose. If the purpose is to improve professional practice, literature review should be based on the problem encountered in the profession. Therefore, when one looks to the literature for a solution, one may rely on other people's literature reviews, or may seek out primary research reports to find one that seems to fit his/her situation. When a literature review is conducted to provide a comprehensive understanding of what is known about a topic, the process is much longer. An example of this type of review (Literature Review on Teacher Education in the 21st Century), is available on http://www.scotland.gov.uk/Resource/Doc/325663/0105011.pdf

6.3 Types of Literature Reviews:

Literature review can be broadly divided into two: narrative literature review and systematic literature review.

6.3.1 Narrative Literature Review:

This type of review critiques and summarizes a body of literature and draws conclusions about the topic in question. The body of literature is made up of the relevant studies and knowledge that address the subject area. It is typically selective in the material it uses, although the criteria for selecting specific sources for review are not always apparent to the reader.

This type of review is useful in gathering together a volume of literature in a specific subject area and summarizing and synthesizing it. The primary purpose is to provide the reader with a comprehensive background for understanding current knowledge and highlighting the significance of new research.

It can inspire research ideas by identifying gaps or inconsistencies in a body of knowledge, thus helping the researcher to determine or define research questions or hypotheses. Equally, it can help refine or focus a broad research question and is useful for both topic selection and topic refinement. It can also be helpful in developing conceptual or theoretical frameworks.

6.3.2 Systematic Literature Review:

In contrast to the narrative review, systematic reviews use a more rigorous and well-defined approach to reviewing the literature in a specific subject area. Systematic reviews are used to answer well-focused questions about a problem.

Parahoo (2006) suggests that a systematic review should detail the time frame within which the literature was selected, as well as the methods used to evaluate and synthesize findings of the studies in question.

In order for the reader to assess the reliability and validity of the review, the reviewer needs to present the criteria used to formulate the research question, set inclusion or exclusion criteria, select and access the literature, assess the quality of the literature included in the review, and analyze, synthesize and disseminate the findings.

The purpose of a systematic review is to provide as complete a list as possible of all the published and unpublished studies relating to a particular subject area. While narrative review attempts to summarize results of a number of studies, systematic review uses explicit and rigorous criteria to identify, critically evaluate and synthesize all the literature on a particular topic.

6.4 The Process of Literature Review:

No matter what the reason for the literature review or the paradigm within which the researcher is working, many aspects of the literature review process are the same. A general outline for conducting a literature review is provided in Table 6.2.

Table 6.2. The Literature Review Process
• Identify a research topic. • Review secondary sources to get an overview of the topic. • Develop a search strategy and use appropriate preliminary sources and primary research. Journals, check the references at the end of relevant research publications. Access personal networks. • Conduct the search and select specific articles to review. • Obtain full text references (e.g. Journal articles or books). • Read articles and prepare bibliographic information and notes on each article. • Evaluate the research reports. • Synthesize the findings. • Writing the review. • Use the literature review to gain a conceptual framework and to formulate research questions, hypotheses, or both.

6.5 Identify Research Topic:

The first step in literature review is to identify the topic of the review/research. The student undertaking a research study may have decided this already. However, for the individual undertaking a non-research based literature review this will be the first step.

Researchers should be flexible in their conceptualization of the research problem being investigated, and they should begin with a broad idea and be prepared to narrow it down as they progress through the search.

The students who are beginning a literature review may find that their topics shift as they become more familiar with the area of research. As they analyse more and more research they may change their topics, and this is a normal part of an evolutionary process of developing the topic.

A research topic can emerge from a wide variety of sources, including the researcher's interests, knowledge of social conditions, observations of educational and psychological problems, challenges that arise in one's professional practice, readings in other courses, talking to other researchers, and the availability of funds to conduct research on a specific topic (sponsored research). Any of these is appropriate as a source to help Identify the primary research topic. The researchers who are interested in conducting a comprehensive review of literature must study topics that appear in the literature.

a. Review Secondary Sources to get an Overview:

A good literature review written by someone else can provide the researcher with an overview of what is known about the chosen research topic. Specific sources that one can look for literature reviews include journals that typically publish literature reviews/abstracts, such as the Indian Educational Review, Review of Educational Research, Harvard Educational Review, and the Psychological Bulletin, and books and doctoral dissertations that contain literature reviews.

Other sources of review are survey of Educational Research by NCERT, Encyclopedia of Educational Research, and Handbook of Research on Teaching. Education Year Book and the World Yearbook of Education etc.

6.6 Develop a Search Strategy:

It is important for the researchers to develop a search strategy for locating research studies of sources or the Purpose of review. The search process normally includes identifying preliminary, ascertaining primary research journals, and personal networking. However, the researcher has to decide the best strategies to be followed in his/her search process.

6.6.1 Identify Preliminary Sources:

Preliminary sources include databases and indexes that contain a compilation of bibliographic information. Abstracts, and sometimes full text articles for a wide range of topics and are accessible in print form, on compact disks (CD-ROM), or through online services.

Examples of the most frequently used preliminary sources are Educational Resources Information -Centre (ERIC), ProQuest Education Journals, PsycINFO, PsycARTICLES, Questia, and JSTOR. World Wide Web sites are easily and pervasively available to assist the researcher in the literature search. For example, http://www.gobookee.orgproyides a good number of research literature in various subjects. Yahoo! and Google are the top two choices for search engines.

These two search engines are recognized because of the size of their databases, ability to search HTML and PDF files, accuracy in results, and advanced searching power using Boolean logic. However, the WWW sites do not have a peer review system to screen what is accepted (as most professional journals do).

Therefore, scholars raise questions about the quality of information available from those sources. In addition, the Web sites are not designed to contain information specifically about research in education. The computerized databases are a tremendous resource for the researcher in the literature review phase of a project.

A researcher can identify thousands of references by only a few keystrokes on the computer. Because of the tremendous coverage provided by the databases, the researcher should plan to include a search of appropriate databases in the literature review process.

One important limitation of the available databases is that you can get from them only what was put into them. In other words, the databases are selective about the journals they include.

6.6.2 Identify Primary Research Journals:

Additional primary research articles can be identified by examining the reference lists found at the end of relevant journal articles or books. You can also go directly to journals that publish articles related to your topic. This is especially important in light of the selectivity of the databases mentioned above University libraries often subscribe to a number of databases and access can be gained using student or staff passwords.

6.7 Personal Networking:

Additional resources can be found by talking to people who are doing work in areas related to your interest. This can include people at your own institution or those you meet through professional associations, such as All India Association for Educational Research, Council for Teacher Education (India), American Educational Research Association, American Evaluation Association etc.

Talking to people who have completed related works can reveal sources that you were unaware of, such as unpublished research reports, and provide you with leads from the work that is in progress.

a. Conduct the Search and Select Specific Articles to Review:

In the process of searching literature the researcher should make a plan to explore preliminary sources, check the table of contents, abstracts, and lists of references in primary research journals. Access the personal network, and involve community members as appropriate the search strategy for accessing preliminary sources is described below. First select the preliminary sources that you think contain the best Information on your topic. Then identify key terms that will help you locate the literature Included in the database of your choice. Key terms are used to find a primary research article that is "exactly" on target and identify the terms used to describe that article. Most databases give you many choices for searching, such as title, author, abstract, subject or full text. The title, author, and abstract choices are fairly self - explanatory. Author and title are not usually used in the beginning of a literature review because you usually are not seeking a specific article during the early stages of searching.

If you have difficulty in finding references using your own key word vocabulary, it is a good idea to consider alternative keywords with similar meanings that might elicit further information. Some of - these alternative keywords can be gleaned from the database thesaurus. Further, you can refine your search in the following ways:

- Truncate the terms you use. This has the effect of broadening the search to include any terms that begin with the letters that you enter, no matter how they end. In ERIC the truncating symbol is a '?'.Therefore, entering sex? For example, would include sex, sexual, sexes, and so on, and deaf? Would include deaf, deafness, deafened, and so on
- Use Boolean operators to combine terms. For combining key words many databases use commands called 'Boolean operators'. The most common Boolean Operators are 'AND', 'OR' and 'NOT'. The purpose of these operators is given below.
    - 'AND' -Look for articles that include all the identified keywords.
    - 'OR' -Look for articles that include any of the identified keywords.
    - 'NOT' -Exclude articles that contain this specific keyword.
- There are other ways to limit the search, such as by year of publication or limiting the field that is searched (e.g., title only).

Certain stop words are not allowed to be used as key words (e g., about, all, its), but all of these things can be learned by reading the online instructions. As you get into using a database, it is always a good idea to read the online instructions to see what can be accomplished and how.

- The search process can be broadened by inclusion of additional databases or indexes. For example, when you search PsycARTICLES using the same descriptors (i.e., sex? and abuse and deaf?), you would find additional references that do not figure in ERIC.

Most databases provide an abstract of the articles listed. By scanning these abstracts, you can make a decision as to the worth of obtaining the complete article. Advances in technology now also make it possible to view many full text articles while you are engaged in the search process. Hence, researchers are faced with a bit of a paradox concerning the amount of time it takes to do a literature review.

If you have the abstract only, you read it quickly and decide if it is what you want. If you think it is and full text is not available, then you need to go to the library or order the article through interlibrary loan or some other mechanism.

b. Obtain Full Text Resources:

Many journal articles and books are now available online in full text versions. If you cannot obtain the article in this manner, then it would be good to check the list of holdings at your library. If the Journal you seek is held by your library. You are in luck: Go to the shelves and read the article. However, if your library does not have the item, you may avail yourself of an interlibrary loan service.

If you have chosen to review an edited document from an ERIC search, that document may be available in full text online However, if it is not, then the document should be available for your review on microfiche in the library. A microfiche is a sheet of IIIm that contains micro. Images of printed material. A copy of film 4" x 6" card contains the material of one hundred printed pages of 9 x 11" size (Sharma, 2011). The microfiche are organized in ascending order according to their ED numbers, so they are usually easy to find.

c. Read and Prepare Bibliographic Information and Notes:

Once you have the article in hand, read the document to determine if it is really what you want. The summary or abstract at the beginning of the paper will help your decision as to whether it is worthy of further reading or inclusion. At this point, it will be beneficial to classify and group the articles by type of sources (Table 2). You decide that it is relevant to your topic, you have to record bibliographic information and notes on each article. This can be done electronically or manually by using old-fashioned note cards.

Table 6.3. Defining the Types of Sources for A Review

- Primary source: Usually a report by the original researchers of a study.
- Secondary source: Description or summary by somebody other than the original researcher, e.g. a review article.
- Conceptual/theoretical: Papers concerned with description or analysis of theories or concepts associated with the topic.
- Anecdotal/opinion/clinical: Views or opinions about the subject that are not research, review or theoretical in nature. Clinical may be case studies or reports from clinical settings.

6.8 Bibliographic Information:

If you are searching such databases such as ERIC or PsycARTICLES, you can use a new digital resource called Reworks (http://www.refworks.com/) to electronically save the bibliographic information about all the references that you select. When you are ready, Reworks will print out a reference list in APA format (or the format that you select). That is not all: If the article is available in full text, you can save it in Ref Works with the bibliographic information.

If you do not have access to this electronic resource, then you can save the bibliographic information on note cards or in a word processing document. The important thing is to make sure you get ALL the information you need when you are working with the document so you do not have to try to find it later when you are writing up your literature review. The bibliographic information should be complete and accurate. Some of the problems associated with recording bibliographic information have been reduced because of the ability to print such information directly from the computer screen. Although several options are available for the format of recording bibliographic Information, the most common style for education and psychology is based on the American Psychological Association's Publication Manual.

The basic format for citations is given in Table 4. There are differences in citation style associated with different types of documents books, government reports, etc.), so it is better to obtain a copy of the APA Publication Manual to books, chapters in guide the compilation of bibliographic information. In addition, APA has added a great deal of information about how to handle Web-based information. You can go to www.apa.org for an update on changes that they recommend and click on their publications link.

Table 6.4. Format for Citations

Journal	Author's Last Name. Initials. (Date). Title of journal article. Title of Journal, volume number (issue number), page numbers. Example: Sullivan, P. M. (1992). The effects of psychotherapy on behavior problems of sexually abused deaf children. Child Abuse and Neglect: The international Journal, 16(2), 297-307.
Book	Author's Last Name, Initials. (Date). Title of book. Place of Publication: Publisher. Example: Mertens, D. M. (2009). Transformative research and evaluation. New York: Guilford.
Book Chapter	Author's Last Name. Initials. (Date of publication). Title of chapter. In Name of Editor (Ed.), Nome of book (page numbers of chapter). Place of publication: Publisher. Example: LaFrance, 1. & Crazy Bull, C. (2009). Researching ourselves back to life: Taking control of the research agenda in Indian Country. In D. M. Mertens& P. Ginsberg (Eds.), Handbook of social research ethics (pp. 135-149). Thousand Oaks, CA: Sage

A. Notes on Each Study:

Exactly what notes to write for each study varies greatly and depends on the nature of the study, the purpose of the review, and the intended use of the data. One can use an indexing or summary system (or a combination of both) to prepare notes on the studies. Although there are slight variations in the criteria proposed in the indexing and summary systems, generally they are concerned with the title of the article, the author, the purpose and methodology used in a research study, and findings and outcomes. It is also useful to incorporate comments or key thoughts on your response to the article after it has been reviewed. The following outline can be helpful in preparing notes on the studies gathered by the reviewer.

a. Full bibliographic information including title, author and year etc
b. Purpose of the study, research questions/hypothesis
c. Theoretical framework/paradigm of researchers)
d. Design, including specific research approach, sampling strategy, data collection instruments and procedures
e. Data analysis strategy
f. Results/major findings
g. Conclusions/recommendations
h. Researchers own evaluation (Including strengths and weaknesses and ideas for your own research, such as promising methodological or conceptual suggestions).

B. Evaluate the Research Reports:

Evaluation of research studies starts with a critical analysis of the research reports. The criteria for critically analyzing literature reviews depend on the nature of the review being analysed. A literature review that serves as an introduction to a primary research study reported in a journal would be subject to a different type of scrutiny than would a comprehensive literature review on a topic. A framework initiated by Hart (1998) and extended by Boole and Bede (2005) provides a way to assess the quality of a literature review. This framework includes five categories: coverage, synthesis, methodology, significance, and rhetoric.

Coverage refers to the adequacy of the coverage of the topic, as well as making explicit criteria for exclusion and inclusion of studies for the review. Does the reviewer include relevant works and exclude irrelevant ones? Writing a dissertation does not mean citing every study ever written on your topic. Coverage should be judged in terms of comprehensiveness, breadth, exclusion, relevance, currency, availability, and authority. Researchers can bias the results of a literature review by excluding data that is methodologically questionable, based on their own personal, subjective judgment. Or they may present conclusions that are more firm and clear-cut than is justified because of the exclusion of studies with "murky" results. Without a clear specification of the method used to search for research and of the criteria used for inclusion or exclusion, it is difficult to judge the quality of a review.

Synthesis refers to how well the author summarized, analysed, and synthesized the selected literature on a topic. The criteria include how well the author (a) distinguished what has been done in the field from what needs to be done, (b) placed the topic or problem in the broader scholarly literature, (c) placed the research in the historical context of the field, (d) acquired and enhanced the subject vocabulary, (e) articulated important variables and phenomena relevant to the topic, and (f) synthesized and gained a new perspective on the literature.

To satisfy these criteria, the writer needs to identify inconsistencies in the literature, provide clarity discussing the strengths and weaknesses of the individual studies as factors that influence the interpretation of their results, and use the extant knowledge base to suggest directions and topics for additional empirical investigations.

Methodology as a criterion for judging a literature review refers to the author's accurate Inclusion of details about method that have relevance for identification of methodologies and research techniques, and their strengths and weaknesses, and discussion of the relationship between theories and ideas in the field to the research methodologies. Literature reviews should not be simple summaries of findings of previous research; they should be critical analyses of previous research. In order to critically analyse the strengths and weaknesses of prior research, several skills are necessary. One is the ability to accurately identify the methodologies; a second IS the ability to identify strengths and weaknesses in the methodologies and how they impact the interpretation of results.

Significance as a criterion for judging a literature review includes establishing both the practical and the scholarly significance of the research problem. While some research studies will focus more or less on one of these aspects, it is useful to provide implications for both the practical and scholarly significance of research. Rhetoric refers to the writers' ability to organize and write cogently about the literature in such a way that they can articulate and support their claims about the knowledge in the field. The ability to critically analyse research is also a skill that becomes more holistic with experience. When you are in the beginning stages of learning critical analysis, it is helpful to look at each section of the research study. Later, you will be able to look at other aspects of the article, such as how the author handled certain aspects of data collection, analysis, credibility building, or ethics.

You can then do comparisons across studies on these dimensions, analyzing how and why texts differ, how they relate to theoretical readings, whether the authors are justified in their methods or presentations, and how they can help you in your own decisions about research. With each research article that you review, you will increase your ability to determine the quality of the author's work and the validity of the findings. Once you have evaluated the research report, you should return to your note cards or files and enter your own assessment of the strengths and weaknesses of the research.

A. Synthesize the Studies:

Before actually doing the synthesis of the studies, the researcher needs to develop a framework for organizing the studies surveyed. This framework should be flexible because it might add, delete, or redefine categories as the researcher moves through the review process. The organization of material in an objective manner and the structure of the review are crucial to its comprehensiveness. To some extent, the structure will depend on the purpose of the review. It is important to be logical and there are some key elements that need to be Included in all literature reviews.

One can adopt a thematic approach to organize the studies. For example, studies on teacher attrition and retention in special education may be analysed under lour major themes: teacher characteristics and personal factors, teacher qualifications, work environments, and teachers' affective reactions to work. It can also include a critical analysis of definitions, concepts, and methods used to study special education attrition.

Two main options exist for the synthesis of research studies: narrative and quantitative methods. The choice of the type of synthesis depends on the type of extant research literature on a topic and on the purpose of the researcher.

6.9 Narrative Synthesis:

The narrative approach to literature synthesis is most commonly used in primary research studies. It is appropriate for both qualitative and quantitative studies. In a narrative synthesis, the writer must organize the studies in a conceptually logical order and provide sufficient detail about the studies to support relevant critical analysis of them. The amount of detail provided (as well as the number of studies cited) will be influenced by the purpose of the literature review.

Typically, the literature review section of a journal article includes a limited number of references that are selected on the basis of relevance to the problem at hand, presenting a balanced picture, and establishing a rationale for the reported research.

A literature review for a research proposal is usually more extensive. If the research proposal is for a thesis or dissertation, it is expected to be quite comprehensive in most universities.

If you organize your literature into meaningful categories as you collect it, then this makes your writing easier. Provide an overview 01 your topic and describe the methods you used to search the literature.

Then provide an advance organizer for the reader of the subtopics that you will address. For each study make a determination if it is Important to report details of its strengths and weaknesses in order to establish the overall picture of knowledge in the field or to provide support for your choice of methods.

It is possible to explain several studies in detail and then cite other studies that agree or disagree with the findings of those studies, rather than a detailed critique of every study in your literature review.

Sometimes literature reviews include a separate section on the proposed study's theoretical framework based on prior research. The literature review should lead to a statement of the need and purpose for the study, research questions, and hypotheses.

a. The Quantitative Method:

The results of literature review can be synthesised in a quantitative from known as meta-analysis. Meta-analysis is the process of taking a large body of quantitative findings and conducting statistical analysis in order to integrate those findings and enhance understanding. Meta-analysis is seen as a form of systematic review which is largely a statistical technique.

It combines the results of many studies by using summary numbers called Effect Sizes (Dooley, 2001). According to Glass (cited in Maksimovic, 2011) meta-analysis is a "statistical analysis of a set of analytical results from individual studies, with the purpose of synthesis of the scientific research findings".

A meta-analysis does not use primary empirical material, but the results obtained from the basic data. In this sense, meta-analysis is just one type of secondary analysis, in other words, it is a secondary analysis used for integration (synthesis) of the results derived from multiple primary analyses. This helps to draw conclusions and detect patterns and relationships between findings.

One early and influencing example of meta-analysis by Smith and Glass (cited in Dooley, 2001) integrated 375 evaluations of psychotherapy outcomes. Each study contained at least one contrast between the average treated and control patients.

The authors "standardized' each of the between-group differences by dividing it by the standard deviation of the control group.

The resulting index d is an example of an Effect Size. For example a d of 1.3 means that the treated group improved 1.3 standard deviations more than the control group.

The authors averaged all of these ds across studies to produce an overall effect size using this method they found that psychotherapy clients looked better off at outcome than 75 percent of the control clients in the literature as a whole.

A meta-analytic review of studies on "educational outcomes of tutoring" by Cohen ET. Al (1982) is available at http://aer.sagepub.com/content/19/2/238

b. Writing the Review:

Once the appraisal of the literature is completed consideration must be given to how the review will be structured and written. The key to a good review is the ability to present it in a clear and consistent way.

Avoid long and confusing words and keep Jargon to a minimum. Sentences should be kept as short as possible with one clear message and spelling and grammar should be accurate and consistent with the form of English being used.

It is crucial to organize the material in a structured and objective way. To some extent, the structure will depend on the purpose of the review. For example, systematic reviews have a clear structure that must be followed and that will dictate for the most part how the writing should be undertaken.

However, for most students or practitioners a review is either part of a course work assignment, research proposal or research dissertation, and as such, there is some freedom in how the writing is structured. Nonetheless, it is important to be logical and there are some key elements that need to be Included in all literature reviews

According to Burns and Grove 12007) the review should include an introduction, body and conclusion. The length of literature reviews vary and word limits and assignment criteria must be considered in the overall construction. If it is a standalone review, an abstract may also be necessary. An abstract is a short summary of the findings of the review and is normally undertaken last (Hendry and Farley, 1998).

Introduction: The introduction should include the purpose of the review and a brief overview of the 'problem'. It is important that the literature sources and the key search terms are outlined. Any limits, boundaries or inclusion/exclusion criteria should be clearly described.

Some comment on what was found in the literature should be offered, that is, whether there was a dearth or wealth of literature on the topic.

This gives the reader some insight into the breadth and depth of the literature sourced and also facilitates some judgment as to the validity of the claims being made.

Main body:

The main body of the report presents and discusses the findings from the literature. There are several ways this can be done (see Table 6.6).

Regardless of the manner in which the main body of the review is framed, there are key points that must be considered. Literature that is central to the topic should be analysed in-depth here.

When discussing empirical or research literature a critical review of the methodologies used should be included. Care must be taken, however, that the review does not end up just as a description of a series of studies.

- It is best to avoid broad sweeping statements about the conclusiveness of research studies. Polit and Beck (2006) suggest that when describing a study's findings it is best to use language that indicates the tentativeness of the results rather than making definite statements about the research.
- It is necessary for the reviewer to remain objective about the literature and personal opinions about the quality of research studies should not be included. Review should not be a series of quotes or descriptions; rather it needs to be written succinctly in the writer's own words.
- The reader should know that the reviewer has understood and synthesized the relevant information, rather than merely describing what other authors have found. The review should read like a critical evaluation of the information available on the topic, highlighting and comparing results from key sources.
- If using a thematic approach, the account should flow logically from one section or theme to the next, to maintain continuity and consistency (Beyea and Nicholl, 1998). This can be achieved by summarizing each theme or section and outlining how it is related to the ensuing one.
- In respect of theoretical literature, consensus or difference regarding the topic should be outlined. Sometimes, where the theoretical literature dominates and there are few studies undertaken in the area of interest, the review may include an analysis of methodologies used across the studies.
- Inconsistencies and contradictions in the literature should also be addressed (Coiling, 2003) as should the strengths and weaknesses inherent in the body of literature.
- The role of the reviewer is to summarize and evaluate evidence about a topic pointing out similarities and differences and offering possible explanations for any Inconsistencies uncovered (Polit and Beck, 2006).

Table 6.5: Framing the Review		
Approach	Definition	Advantages/Disadvantages
Dividing the literature into themes or categories	Distinct themes from literature are discussed	• Most popular approach. • Allows integration of theoretical and empirical (research) literature. • Care must be taken in ensuring that the themes are clearly related to the literature
Presenting the literature chronologically	Literature divided into time periods	• Useful when examining the emergence of a topic over a period of time
Exploring the theoretical and methodological literature	Discussion of theoretical literature followed by exploration of methodological literature that would give some Indication of why a particular research design might be appropriate for investigating the topic	• Useful when the body of literature is largely theoretical with little or no empirical (research) literature. • Can be used to identify the need for qualitative studies
Examining theoretical literature and empirical in two sections	Where the topic has both theoretical and empirical literature and each is discussed separately	• May tend to be a description rather than a critical review literature

6.10 Conclusion:

The review should conclude with concise summary of the findings that describes current knowledge and offer a rationale for conducting future research.

In a review, which forms part of a study, any gaps in knowledge that have been identified should lead logically to the purpose of the proposed study. In some cases, it may also be possible to use the developed themes to construct a conceptual framework that will inform the study. In all reviews, some recommendations or implications for practice, education and research should be included.

6.11 References:

The literature review should conclude with a full bibliographical list of all the books, journal articles, reports and other media, which were referred to in the work. Regardless of whether the review is part of a course of study or for publication, it is an essential part of the process that all sourced material is acknowledged. This means that every citation in the text must appear in the reference/bibliography and vice versa.

Omissions or errors in referencing are very common and students often lose vital marks in assignment because of it. A useful strategy is to create a separate file for references and each time a publication is cited, it can be added to this list immediately. Remember, the reference list may be a useful source of literature for others who are interested in studying this topic (Coughlan et al, 2007), and, therefore, every effort should be made to ensure it is accurate.

6.12 Using the Literature Review:

Literature review serves many purposes. It establishes a historical perspective on the intended research, provides a vision of the need for additional research, and enables the researcher to develop a conceptual framework for the research. The conceptual framework allows the researcher to generate research questions and hypotheses to guide the design and conduct of the research. In qualitative research, the researcher will refine, modify, add, and even discard questions throughout the progress of the study Therefore, qualitative researchers are advised to begin with broader questions that can be modified in response to discoveries made during the study. No matter which research paradigm or approach is used, the literature review is an essential Ingredient In the research process.

The narrative or statistical synthesis serves as a basis for the literature section of a research proposal or report. It is important for the proposal writer to realize that each institution and sponsoring agency has its own requirements for proposal writing, so it is best to check with those sources before proceeding with writing. Proposal writers must also realize that in synthesis of research they are "selling" their ideas to a research committee, institutional review board, or funding agency. So above all, make it clear why the research is important (based on what is known from the existing literature).

6.13 Conceptual Framework:

Conceptual framework is a written or visual presentation that "explains either graphically, or in narrative form, the main things to be studied - the key factors, concepts or variables - and the presumed relationship among them" (Miles and Huberman, 1994). It provides the structure/content for the whole study based on literature and personal experience.

A researcher's original conceptual framework influences the planning and conducting of the literature review. However, if a researcher keeps an open mind throughout the literature review process, a more sophisticated and modified conceptual framework would emerge.

Table 6 provides an overview of the three theoretical frameworks that are used in educational research. The job of the researcher is not to become an expert in any of these three theories. Instead, it is to realize which one best fits the research topic and goals.

In so doing, this will help the researcher focus ever more on how to structure, where to look in the literature for solutions, and better understand the potential and limitations of the research topic (Butin, 2010). The question for you is which theoretical perspective to choose and how to even begin to know by which criteria to make this choice. For a better understanding of how educational practice can be examined through the above three theoretical perspectives frameworks read The Education Dissertation: A Guide for Practitioner Scholars by Butin (2010, pages 58-63).

Table 6.6: Key Theoretical Perspectives in Educational Research			
	(Post) Position	Interpretivism	Critical Theory
Assumptions about "reality"	An objective reality exists and can be correctly measured (with good enough tools) and adequately described (with clear enough language)	Reality is inter-subjective in that it is socially constructed such that it can he described and represented through diverse perspectives.	Reality is a function of dominant and ideologies that determine how reality functions and potentially undermine the Ideologies' own functioning.
Assumptions about "truth"	Truth is objective. The key question is, What Is the right answer?	Truth Is constructed. The key question is, What is the meaning?	Truth is linked to power. The key question is, Who benefits?
Key goals	Uncover the "right" variables that determine "best" outcomes.	Search for patterns of meaning.	Examine, expose, and/or overturn hidden relations of power.
Key outcome	A number; a "best" practice	A story	An attack; an insight
Unit of analysis	The variable	The act of meaning making	Categories of oppression (e.g. race, class, gender, sexuality); relations of truth making (e.g. knowledge, power, identity)
Key criteria	Reliability, internal and external validity	Trustworthiness; authenticity	Theoretical consistency and insight; impetus for change

Source: Butin (2010).

The question for you is which theoretical perspective to choose and how to even begin to know by which criteria to make this choice.

For a better understanding of how educational practice can be examined through the above three theoretical perspectives frameworks read The Education Dissertation: A Guide for Practitioner Scholars by Butin (2010, pages 58-63).

6.14 Research Questions and Hypotheses:

The research questions operationalize the objectives of the proposed research, focus the research hypotheses, and clarify what information needs to be collected from what sources under what conditions.

The literature review serves as a foundation for formulating research questions and or hypotheses. The investigator makes use of the results of the literature review to ensure that the research questions are well grounded in current theoretical and empirical knowledge.

The research questions should be stated in terms of theory and application, and amenable to the formulation of clear hypotheses and operational definitions. The hypotheses provide clear direction for the research procedure and methodology. In fact hypotheses originate essentially from the same background that serves to reveal the research problem.

According to Goode and Hat (cited In Sharma, 2014 there are three major difficulties in formulating good research hypotheses: the absence of knowledge of a theoretical framework, inability of the investigator to utilize the knowledge of the theoretical framework, and lack of awareness of important research techniques. It is the review of literature that provides the researcher with a sound understanding of the theoretical framework and important research.

6.15 Summary:

A review of scholarly literature provides information that can be used to investigate a topic of importance to learn what is known about that topic for its own sake (i.e , to improve teaching or therapeutic practices, or as a basis for designing a research study The formulation of a research topic is enabled by reading about research that has already been conducted because the reader can figure out what is already known as well as become acquainted with the strengths and weaknesses of methods used in prior research, Multiple sources exist for the conduct of literature reviews, including secondary sources that provide an overview of past research and primary sources that report original research. Primary sources can be identified through several different electronic means. Persons conducting literature reviews can summarize their results in narrative form or a quantitative form known as meta-analysis.

A literature review is used to develop and support research questions and hypotheses of a study Researchers can also benefit by looking outside of published scholarly research to provide a different perspective on what needs to be studied and how it should be studied.

6.16 Suggested Readings:

1. Beyea, L. (1998) Writing an integrative review AORN Journal.67 (4):877-80.
2. Boote, D.N. & Bede, P. (2005). Scholars before researchers: on the centrality of the dissertation literature review in research preparation. Educational Researcher. 34 (6): 3-15.
3. Burns, N., & Grove, S.K. (2007). Understanding Nursing Research — Building an Evidence Based Practice. (eedn.). St. Louis: Saunders Elsevier.
4. Butin, D.W. (2010). The Education Dissertation: A Guide for Practitioner Scholars. Thousand Oaks, Calif: Corwin.
5. Carnwell, R., & Daly, W. (2001). Strategies for the construction of a critical review of the literature. Nurse EducProct, 1: 57-63
6. Cohen, G. (1990). Memory.ln Roth, I. (Ed.), the Open University's Introduction to Psychology. Volume 2. (pp. 570-620). Lawrence Eribaum: Milton Keynes.
7. Cohen, P. A., Kulik, J. A, &Kulik, C.C. (1982).Educational Outcomes of Tutoring: A Meta-analysis of Findings American Educational Research Journal. 19 (2): 237-248.

8. Coning.J. (2003). Demystifying the clinical nursing research process: the literature review.UrolNurs, 23(4): 297-9.
9. Coughlan, M., Cronin, P., & Ryan, F. (2007). Step-by-step guide to critiquing research. Part 1: quantitative research. Br J Nurs.16 (11): 658-63.
10. Dooley, D. (2007). Social Research Methods. (4tnedn.). New Delhi: Prentice Hall of India.
11. Hendry, C. & Farley. A. (1998) Reviewing the literature• a guide for students Nuts Stand. 12(44):46-8
12. Gadsden, V L. (2008). The arts and education: Knowledge generation. Pedagogy and the discourse of L earning. Review of Research m Education 32(1), 29-61
13. Hart. C (1998). Doing a literature Review London: Sage Publications.
14. Ima, G. Adolescent Depression and Attachment Available on https://owl.english.purdue.edamedia/pc11/20070515025950_667.pdf
15. Literature Review and Focusing the Research. http.//www.sagepub.com/upm-data/29986Chapter3.pdf
16. Maksimovie, 1. (2011). the application of meta-analysis in educational research. Philosophy, ry Sociology, Psychology and Histo.10 (1): 45 - 55.
17. Miles, M. B., & Huberman, M. A. (1994). Qualitative DOW Analysis: An Expanded Sourcebook. (2nd edn.). Beverley Hills: Sage.
18. Parahoo. K. (2006). Nursing Research - Principles, Process and Issues. (2r. sedn.). Hounds mill: Palgrave.
19. Patrick, Li & Munro. S. (2004). The literature review: demystifying the literature search. Diabetes Educ. 30(1):30-8.
20. Polit, D.F., & Beck, C.T. (2006). Essentials of Nursing Research: Methods, Appraisal and Utilization. (C'edn.). Philadelphia: Lippincott, Williams & Wilkins.
21. Sharma, Y.K. (2011). Elements of Educational Research. New Delhi: Kanishka Publishers.

ISBN: 978-93-90847-07-5

Chapter - 7 : Styles of Referencing

Rimmi Datta

Lecturer, Suniti Educational Trust B.Ed. & D.El.Ed College, Kalyani, Nadia, West Bengal, India.

&

Jayanta Mete

Department of Education, Faculty of Education, University of Kalyani, Kalyani, West Bengal, India.

7.1 Introduction:

Educational institutions and scientific publications refer to all the resources used when writing. Students and researchers see this as a complex process that requires a lot of time and effort. The complexity of this practice increases for students as they need to consult different types of information materials when writing research papers and related papers (final papers, essays, articles, research projects, etc.). Information materials mentioned or cited in such research articles include books, journals, journals, newspapers, reports, student projects (such as thesis and research), dictionaries, encyclopedias, letters, lecture/class notes, posters, manuals, brochures, directories, and photographs. Other electronics companies include web pages, social media texts, archived emails and messages, and audio and video files online. Teachers, Students, and researchers are reminded of the importance of citation and referencing in this chapter.

7.2 Bibliography:

A bibliography is a list of articles (such as books and articles) written on a specific topic or by a specific author. A bibliography is a list of sources you have used (if mentioned) in the process of researching your writing.

Textbook, as a discipline, is the tradition of studying books as a subject of physical and cultural theatrics; in this sense, it is also known as the bibliography. Carter and Barker (2010) describe bibliography as "a twofold scholarly discipline—the organized listing of books and the systematic description of books as objects". Generally, a bibliography should include: author name, job title, name of companies and organizations that published a copy of your source, date of publication of your copy, page number of your source (if applicable) part of the volume from multiple sources).[1]

7.2.1 Types of Bibliographies:

- **Enumerative Bibliography:** The author of the computational bibliography lists the instructions according to a specific arrangement. This type of bibliography is most often used by students writing research papers.

These academic authors set up computational bibliographies by author, subject, date, or some other scheme. The items they list share a common theme such as topic, language or duration. The bibliographer gives enough information about the source to guide readers to this source.

Detailed information such as details of physical properties in the author's book is not included in the numerical bibliography. Examples of numerical bibliographies are the card catalog, the list of references in the research paper, or the works cited at the back of the history book.

- **Analytical Bibliography:** The author of analytical bibliographies uses them to critically study books. The author of the analytical bibliography may include information about printers and booksellers, descriptions of paper and bindings, or discussions of issues that have arisen as the book evolved from a manuscript to a published book. There are three types of analytical bibliographies: descriptive, historical, and textual. The detailed bibliography closely examines the physical nature of the book. A historical bibliography discusses the context in which the book was produced. A bibliography compares the published work to the author's original manuscript.
- **Annotated Bibliography:** In this type of bibliography, an author creates an alphabetical list of sources. The author of the annotated bibliography describes the type of research done on a particular topic. The author comments on the sources or ads notes. Therefore, in addition to information about research resources, the author comments on the source. The author summarizes.

  This means she gives information about the content of each reference. The author can estimate. This means she evaluates the use of the source. The author may also reflect. This means she gives her perspective on the use of text for her particular research.[2]

7.3 Referencing:

It can be used as a way to give recognition and appreciation to those who have used it in research work to back up and support your ideas.

Reference is one of the most important aspects of any academic research and not only can your classes be weakened or absent, but your university may also even consider such practices plagiarism and boycott disciplinary action thereafter. It has become a necessary item. Used to identify the source of the work so that everyone can access and understand the material in their way.

Difference between Bibliography and Referencing:

The important difference between a reference and a bibliography is that a bibliography is a list of the resources that you have used to form your ideas on a topic, as well as those mentioned in the assignment and those not cited. A bibliography is a list of sources of information that appears at the bottom of a page. However, a reference is a reference to someone or something, but a bibliography refers to a book, website, magazine, or someone who has researched them. The reference can be used for a thesis, while the library is used for research purposes. The reference is based on primary sources, but the library is based on primary and secondary sources. Both the list of references and the bibliography appear at the end of the written text and are usually organized alphabetically. An article can contain both a list of references and a bibliography.

7.3.1 Importance of Referencing in Academic Writing:

Adds reliability and depth to reference writing. When submitting is cited, paraphrased, or extracted from academic sources, the descriptions describe how they fit into the field of knowledge about writing.

When considering the use of information in an assignment, it is important to assess the reliability and v image of each source. Suggestions usually include a list of text citations and instructions. It is important to understand the specific reference style used in lectures. There is a list of references and several bibliographies in many reference styles. The reference list contains only the details of the source cited in the text.

7.3.2 Different Kinds of Reference Styles:

Depending on how they record the source, scholarly reference styles can be divided into three main categories: desk note style, parenthetical style (or author-date), and number style. Each section has several somewhat different reference styles.

The different categories are described below:

a. Documentary Note Styles:

References are made in footnotes or endnotes, in the style of documentary note (documentary note citation system). Notes are indicated by numbers, which repeat the entire footnote (footnote) at the bottom of the page or after the entire text (endnote). The number is usually placed after the sentence related to the reference has come to a complete stop.

b. Parenthetical Styles or Author-Date Styles:

In the first parenthesized or author-dated style, text references are given in parentheses before the last point of the referenced sentence. APA, Harvard, and MLA are parenthetical reference styles.

c. Numbered Styles:

In numeric style, fonts are specified in brackets or superscript with Arabic numerals, and references are listed in a list of numbered references after the text. References are numbered so they appear first in the text. Vancouver and IEEE are numbered styles.[3]

7.4 Citation and Citation Style:

A citation is a way of giving credit to people for their creative and intellectual work that is used to support research. It can also be used to identify specific sources and combat theft. A citation style refers to the information needed to provide a quote and how information is ordered, as well as punctuation and other formats. Typically, a citation can include the author's name, date, and location of the publishing company, journal title, or DOI (Digital Object Identifier).

Choosing a Citation Style:

There are many different ways of citing resources for research. The citation style sometimes depends on the academic discipline involved. For example:

- APA (American Psychological Association) is used by Education, Psychology, and Sciences.
- MLA (Modern Language Association) style is used by the Humanities.
- Chicago/Turabian style is generally used by Business, History, and the Fine Arts.[4]

7.5 Common and Widely used Referencing Styles:

A. APA Reference Styles: APA's benchmark style (as the American Psychological Association calls it) in the late 1920s, a team of scholars from the fields of psychology, anthropology, and business management established a reference system. APA Reference Style is also known as Author-Date Style. The author's last name and date of publication are enclosed in parentheses, where they are used in the main body of the content. Today, the APA is used in the social sciences as well as other fields of education. The sixth edition of the American Psychological Association Publications Manual (2009) is a detailed guide to the APA reference style. The new version (7th edition) was released in October 2019. Here, we provide basic information on APA instructions. Refer to the American Psychological Association Publications Manual (2009) or APA Online Resources listed below for more details. APA provides good online resources for beginners and advanced APA users.[5]

a. In-Text Citations in APA Style:

In-Text references provide information about the source in the text. Complete information of the source is provided in the reference list. In the APA referencing style, the text references give the last name of the source author and the year of publication. There are two ways to do this; either the author's name is given in the sentence and the year of publication is provided in parentheses, or both items are given for parental reference. The first option, where the name of the cited author is given in the sentence, gives more importance to the cited author.

E.g.: (Thomson, 2003)

Page references are also provided when referring to specific parts of the text in the form of citations or paragraphs. The page number is before 'p'. Or, if successive pages are referred to with 'pp'.

E.g.: (Nilson & Boura, 2007, p. 210)

Second-Hand use of Sources:

If a reference is made by a second hand, it refers to the source, not the source, as indicated in one of the following points:

For a quotation, add "quoted in" in the parenthetical reference:

E.g.: (quoted in Campbell et al. 1995, p. 274).

In an in-text reference with no quotation

E.g.: (Lewis, 2009, 172)

The list of references in the APA is called 'Reference'. Here are examples of different types of fonts. In the reference list, the entries are listed in alphabetical order. French indentation is often used (meaning that the second and subsequent lines of the entry are inserted).

b. APA Referencing in Book:

Book by One Author:

The APA format for book entries in the Reference list looks like this:

Author's last name, Initial(s). (Year of Publication). *Title of the book*. Place of publication: Publisher.

E.g.: Nawani, D. (2016). *Teaching-learning resources for school education*. Sage Publications Pvt.

c. Book by Two or More Authors:

If there are two or more authors, the names are listed as follows. Note that names must appear in the same order as they appear on the title page of the book.

Two Authors:

First author's last name, Initial(s) & Second author's last name, Initial(s). (Year of Publication). Title of the book. Place of publication: Publisher.

E.g.: Mills, D., & Morton, M. (2013). *Ethnography in education*. SAGE.

More than Two Authors:

If there are more than two authors, place a comma between the names of the authors and an ampersand (&) before the last name, for instance like this:

First author's last name, Initial(s), Second author's last name, Initial(s), Third author's last name, Initial(s) & Fourth author's last name, Initial(s). (Year of Publication). Title of the book. Place of publication: Publisher.

E.g.: Book by two or more authors Jain, M., Mehendale, A., Mukhopadhyay, R., Sarangapani, P. M., & Winch, C. (2018). *School education in India: Market, state and quality*. Taylor & Francis.

d. APA Referencing in Journal Article:

The APA format for scholarly article entries in the list of References looks like this:

Last name, Initial of first name(s). (Year of publication within parenthesis). Title of the article. Title of Journal, volume number, inclusive page numbers. doi (digital object identifier):

E.g.: Patel, S. K., & Pancholi, M. D. (2018). Role of RTE, Free Education, Compulsory Education and Mid-Day Meal on Status of Literacy in India. *International Journal of Trend in Scientific Research and Development*, (Issue-2), 1725–1727.

Accessing and citing in-press journal of management articles: The role of Online First and the Digital Object Identifier. Journal of Management, 35, 197-198. Doi: 10.1177/0149206309333552

A. Journal Article With an Article Number:

E.g.: Milligan, L. (2011). Global influences in educational policymaking: Free Secondary Education in Kenya. *Research in Post-Compulsory Education*, (3), 275–287. https://doi.org/10.1080/13596748.2011.601924

B. Journal Article with Missing Information:

a. Missing Volume Number: Stegmeir, M. (2016). Climate change: New discipline practices promote college access. The Journal of College Admission, (231), 44–47. https://www.nxtbook.com/ygsreprints/NACAC/nacac_jca_spring2016/#/46.

b. Missing Issue Number: Schuermann, P. J., Guthrie, J. W., & Hoy, C. (2011). School culture. Education. doi:10.1093/obo/9780199756810-0034

c. Missing Page or Article Number: Kervin, L., & Comber, B. (2019). Teacher research in teacher education. Oxford Research Encyclopedia of Education. Doi: 10.1093/acrefore/9780190264093.013.791

C. Retracted Journal Article:

E.g.: Joly, J. F., Stapel, D. A., & Lindenberg, S. M. (2008). Silence and table manners: When environments activate norms.

Personality and Social Psychology Bulletin, 34(8), 1047–1056.

https://doi.org/10.1177/0146167208318401 (Retraction published 2012, Personality and Social Psychology Bulletin, 38[10], 1378)

B. Abstract of A Journal Article from an Abstract Indexing Database:

E.g.: Hare, L. R., & O'Neill, K. (2000). Effectiveness and efficiency in small academic peer groups: A case study (Accession No. 200010185) [Abstract from Sociological Abstracts]. Small-Group Research, 31(1), 24–53. https://doi.org/10.1177/104649640003100102

C. Monograph as Part of a Journal Issue:

E.g.: Ganster, D. C., Schaubroeck, J., Sime, W. E., & Mayes, B. T. (1991). The nomological validity of the Type A personality among employed adults [Monograph]. Journal of Applied Psychology, 76(1), 143–168. http://doi.org/10.1037/0021-9010.76.1.143

D. Online-Only Supplemental Material to A Journal Article:

E.g.: Freeberg, T. M. (2019). From simple rules of individual proximity, complex and coordinated collective movement [Supplemental material].

Journal of Comparative Psychology, 133(2), 141–142. https://doi.org/10.1037/com0000181

APA Referencing in an Edited Book:

Edited books contain several chapters written by different authors. If you have referred to a specific chapter in an edited volume, the entry in your reference list should therefore be listed under the name of the author(s) of that chapter, not to the whole book.

The APA format for reference list entries of chapters from edited books looks like this: Last name, Initial of first name(s). (Year of publication within parenthesis).

Title of chapter. In [Name of editor] (Ed. /Eds.), Title of book (page numbers of a chapter within parenthesis). Place of publication: Publisher.

E.g.: Scott, C. (2006). Translating the literary: Genetic criticism, text theory, and poetry. In S. Bassnett & P Bush (Eds.), the Translator as Writer (pp. 106-118). London & New York: Continuum

Webpage:

The basic reference list format for webpages looks like this: Authors' last name, Initial(s). (Year of publication). Title of webpage. Retrieved from [URL here]

E.g.: LFIN Foundation. (N. d.). Retrieved November 2, 2020, from LFIN Foundation website: http://schooleducation.com

Published Dissertation or Thesis References:

A dissertation or thesis is considered published when it is available from a database such as ProQuest Dissertations and Theses Global or PDQT Open, an institutional repository, or an archive.

E.g.: Zambrano-Vazquez, L. (2016). *The interaction of state and trait worry on response monitoring in those with worry and obsessive-compulsive symptoms* [Doctoral dissertation, University of Arizona]. UA Campus Repository.
https://repository.arizona.edu/handle/10150/620615

Conference Presentation:

E.g.: Evans, A. C., Jr., Garbarino, J., Bocanegra, E., Kinscherff, R. T., & Márquez-Greene, N. (2019, August 8–11). *Gun violence: An event on the power of community* [Conference presentation]. APA 2019 Convention, Chicago, IL, United States. https://convention.apa.org/2019-video

- **Print Format:**

E.g.: Ediger, M. (2010). *Quality School Education*. Discovery Publishing House.

- **Online/ Electronic Format:**

E.g.: Jain, M., Mehendale, A., Mukhopadhyay, R., Sarangapani, P. M., & Winch, C. (2018). *School education in India: Market, state and quality*[6]

APA 7th Edition:

The American Psychological Association (APA) has updated its style manual in late 2019. This resource provides a list of important differences between the sixth and seventh editions. This reflects the recent printing of the manual as of January 2020. The seventh edition of the APA Publication Manual contains many updates and additions designed to make the APA style more useful to students, teachers, and other academic stakeholders. Although there are many changes to list here, we chose to focus on the changes that are relevant to students and teachers. There are changes in how academic papers are formatted, changes in how the sources are cited, and more. The authors of the 7th edition of the Publication Manual of the American Psychological Association (2020) advise writers to:

- Cite the work of those individuals whose ideas, theories, or research have directly influenced your work.
- Provide documentation for all facts and figures that are not common knowledge.
- Use the author-date system to cite references. This means each work used in a paper has two parts: an in-text citation and a corresponding reference list entry at the end of the paper.

Key Changes in APA 7th Edition:

To keep up with the changing world, the APA updated their style guide in 2019. See APA 7th Edition changes covering in-text citations, reference page, configuration, style mechanics, and tables.

Formatting: When it comes to formatting, APA separates formatting for students and professionals. Ignoring the running header and abstract is a very important difference for students unless asked by professors. Other fundamental changes:

- The running head is no longer required in student papers.
- In professional papers, the words "Running head:" no longer appear on the title page. Only the shortened title and page number should be used.

- Authors may now use additional fonts (Calibri 11, Arial 11, Lucinda Sans Unicode 10, Times New Roman 12, and Georgia 11).
- APA now uses more inclusive language, notably the use of the singular "they."
- Flexible order of pages including tables and figures.

Citations: When the APA made their changes in 2019, one area they examined was in-text citations. In the 7th edition of APA, in-text citations with three or more authors use the last author's last name, followed by others. Forever must be used in-text citations of sources with more than two authors. There is an initial mention of this change.

References: APA 7th Edition made some important changes to its reference page. And through the big changes, it means they provided more examples. And, these new examples show how to cite anything from a scholarly magazine to a YouTube video. Other changes in their instructions:

- Don't state "retrieved from" in the reference list.
- Websites should now be italicized.
- The publisher's location is no longer needed in the reference entry.
- DOIs should be listed as a URL.
- Up to 20 authors for each source should be listed in the reference list. Formerly, APA only required that one list the first 7 authors for a given source.

APA 7 Reference in Books:

E.g.: American Association of Colleges for Teacher Education, & American Association of Colleges for Teacher Education. Teacher Education and Media Project. (1969). *Professional teacher education II; a programed design*. Washington.

E.g.: Merino, N., & Gale Research Inc. (2014). *Education*. Green haven Press.

APA 7 Reference in Journal:

E.g.: Saini, A. K. (2016). The Right of Children to Free and Compulsory Education Act – 2009: As One of the Most Pioneering Academic Reforms in India. *International Research in Higher Education*, 2. https://doi.org/10.5430/irhe.v1n2p58

Siqueira, A. C. (2012). The 2020 World Bank education strategy. *The World Bank and Education*, 69-81. https://doi.org/10.1007/978-94-6091-903-9_5.[7]

A. HARVARD Reference Styles:

Harvard is a commonly used citation style based on author-date and is mainly based in the U.K. And used in Australia.

There is no specific manual for this style. The use of punctuation and other configurations varies from organization to organization. We use the 2016 version of Charles Darwin University (CDU) Harvard Referencing Style Guide to illustrate this style.

Book:

E.g.: Bhatt, D.P. (2012). *Educational technology.* New Delhi: Aph Publishing.

Journal:

E.g.: Megarry, J. (1983). Educational Technology: Promise and Performance. *Programmed Learning and Educational Technology*, 20(2), pp.133–137.[8]

A. **MLA Referencing Style:**

The Modern Language Society (MLA) sets values to identify the resources used in a Research paper. The Modern Language Association (MLA) is the organization responsible for developing the MLA format. It was developed as a tool for researchers, students, and scholars in the fields of literature and language to use a uniform way to format their papers and works. This uniform or consistent method of developing paper or assignment allows for easy reading.

It is mostly applied by the arts and humanities. The Modern Language Association released the 8th and most current edition of their MLA Handbook in April 2016.

MLA Formatting Basics:

- Use white 8 ½ x 11" paper.
- Make 1-inch margins on the top, bottom, and sides.
- The first word in every paragraph should be indented one-half inch.
- Indent set-off quotations one inch from the left margin.
- Use any type of font that is easy to read, such as Times New Roman. Make sure that italics look different from the regular typeface.
- Use 12 point size.
- Double-space the entire research paper, even the works cited page.
- Leave one space after periods and other punctuation marks, unless your instructor tells you to leave two spaces.

MLA 7 Reference in Book:

E.g.: Rajput, J. S., and K. Walia. *Teacher Education in India*. Sterling Publishers Pvt. Ltd, 2002. Print.

MLA 7 Reference in Journal:

E.g.: Home, Richard G. "The Current Status of Educational Sociology." *Journal of Educational Sociology*, vol. 35, no. 3, Nov. 1961, p. 128, doi:10.2307/2264816.

MLA 8 Reference in Book:

E.g.: Adams, Fred, and Society of Education Officers. *Special Education*. Burnt Mill, Harlow, Essex, Councils and Education Press, 1986.

MLA 8 Reference in Journal:

E.g.: Lee, Lay Wah, and Hui Min Low. "The Evolution of Special Education in Malaysia." *British Journal of Special Education*, vol. 41, no. 1, Mar. 2014, pp. 42–58, 10.1111/1467-8578.12048.[9]

7.6 Other Styles of Referencing:

A. VANCOUVER Referencing Style: Several medical journal authors in Vancouver, Canada, agreed on guidelines for those wishing to submit articles to their journal, and in 1976 the Vancouver style got its name. This collaboration later became the International Committee of Medical Journal Editors (ICMJE).
The Vancouver style reference list is called a reference. Vancouver is the number one style. The sources of the continuous text are indicated by Arabic numerals in the first parentheses, and the number sequences in the reference list contain references to the full biography (as it appears in the text).

Book:

E.g.: Sternberg RJ, Williams WM. Educational psychology. Upper Saddle River, N.J.: Merrill; 2010.

Journal:

E.g.: Sandiford P. Educational Psychology and Psychology of Learning: A Textbook in Educational Psychology. Journal of Educational Psychology. 1936; 27(5):392–3.[10]

A. IEEE Reference Style: The IEEE Editing Guide, which describes the style, format, and references for journals, transactions, etc., published by IEEE, serves as the house style for a large number of publications.
The guidelines are a reference style used in university departments. IEEE is an acronym for the Institute of Electrical and Electronics Engineers.

Book:

E.g.: a. Haberle, *Electrical engineering : tables, standards, formulas*. Haan-Gruiten: Verlag Europa-Lehrmittel, 2008. B. R. L. Finney and Leslie Day Zeleny, *Introduction to educational sociology*. Boston: D.C. Heath & Co, 1934.

Journal:

E.g.:

a. R. Ronchi, "Educational Technology in Argentina," *Programmed Learning and Educational Technology*, vol. 17, no. 4, pp. 201–209, Nov. 1980, doi: 10.1080/0033039800170402.[11]
b. E. Mercer, C. B. Moore, and W. E. Cole, "Sociology in Educational Practice.," *Journal of Educational Sociology*, vol. 27, no. 7, p. 335, Mar. 1954, doi: 10.2307/2264011.

A. CHICAGO Reference Style: It is similar to APA and Harvard. It is mostly used for history and economics.

Book:

E.g.: Koenigsberger, H G, and Asa Briggs. 1987. *A History of Europe*. Harlow Etc.: Longman.

Journal:

E.g.: Fine, Ben. 2002. "Economics Imperialism and the New Development Economics as Kuhnian Paradigm Shift?" *World Development* 30 (12): 2057–70. https://doi.org/10.1016/s0305-750x(02)00122-5.[12]

A. TURABIAN Reference Style: It is very similar to APA and Harvard referencing styles. Similar to the Chicago referencing system, it is widely used for history and economics.

Book:

E.g.: Kulke, Hermann, and Dietmar Rothermund. *A History of India*, 1998. Rout, Himanshu, Sekhar, and Prasant Panda Kumar. *Health Economics in India*, 2007.

Journal:

E.g.: Rima, Ingrid. 1996. "Can Neoclassical Economics Be Social Economics?" *Forum for Social Economics* 26, no. 1: 5–13. https://doi.org/10.1007/bf02778861.

Ise, John, and Abba P. Lerner. 1944. "The Economics of Control: Principles of Welfare Economics." *Journal of Farm Economics* 26, no. 4: 804. https://doi.org/10.2307/1232127.[13]

7.7 Head Notes:

Headnotes are used as an introduction to legal documents or as a summary of the text that follows. In academic writing, opening notes are explanatory notes that are included with tables and illustrations. These are written at the bottom of the table or just below the image title and in the form of fonts that are smaller than the original text (for example, 8 or 10 point fonts). Titles are used to define the summary, unit of measure, meaning, etc. Because tables and figures should be able to "stand-alone" without the main text, headnotes should always be used.[14]

7.8 Foot Notes:

When writing a research paper, footnotes are used to illustrate the source of information or citations. Footnotes are mentioned in the text in the same way as quotations. That is, the text referred to follows the superscript number, which corresponds to the footnote of the numbers at the bottom of the page. Footnote is a small note that provides additional content or copyright attributes. Any kind of paper can contain footnotes. These are not used for reference in APA style. Footnotes can be used in a variety of writing styles. Typically, Oxford, Chicago, and Turabian use footnotes for in-text transcripts.

MLA and APA use footnotes, but they provide content or copyright information and are generally not adjectives. Each of these reference style footnotes differs somewhat in the approach and shape of the footnote. The Chicago / Turabian style we use requires footnotes instead of text or parental quotes. The two types of footnotes are:

Content: Supplements or simplifies substantive information; not detailed. Copyright permission: Cites quoted text and any reprinted materials used in the text.[15]

7.9 End Notes:

Endnotes are similar to footnotes in that they are placed at the end of your research paper rather than at the bottom of the page. In books, they can be placed after each chapter or at the end of the book. In many cases, the book publisher will determine the best appointment. Endnotes, as footnotes, are numerically identified in the superscript. The format is similar to footnotes. Endnote numbers must be superscripted. In your text, add a superscript number as soon as there is a quote or reference. Endnotes should be included on the separate endnotes or notes page at the end of the research paper before the work cited or bibliographic page. All first Endnote references should be fully cited. Subsequent references to the same work will be reduced to include only the author's last name and the page number. If the cited source is not specified by the author, use the minimum information required to identify the same work previously cited, e.g. Short title and the page number. Formerly, the Latin terms ibid. and op. cit. were used but they are no longer preferred.

7.10 Conclusion:

This chapter clearly describes the most frequently used and popular bibliography, citation, and citation methods. Methods such as Harvard, APA, Vancouver, MLA, etc. are at the center of this chapter. This chapter also focuses on headnotes, endnotes, and footnotes. Any department of education and / or subject discipline, as noted, may use any methods. Teachers, students, and researchers can benefit from this chapter. Therefore, educators believe that this chapter will be rewarded when undertaking various academic research contributions that are characteristic of the scholarship.

7.11 References:

1. Razik, T., A. (1974). Bibliography of Research in Instructional Media. Educational Technology.
2. Downs, F., S. (1999). Readings in Research Methodology. Lippincott Williams & Wilkins.
3. Moed, H., F. (2006). Citation Analysis in Research Evaluation. Springer Science & Business Media.
4. Walker, J. R., & Taylor, T. W. (2006). The Columbia Guide to Online Style. Columbia University Press.
5. Macfarlane, B. (2010). Researching with Integrity. Routledge.
6. https://apastyle.apa.org/
7. https://libguides.csudh.edu/
8. Publications, C. (2020). Full Student Guide to the Harvard Referencing Style. Creative Cloud Publications.

9. Heath, M. (2009). MLA Made Easy: Citation Basics for Beginners. ABC-CLIO.
10. Williams, K., & Davis, M. (2017). Referencing and Understanding Plagiarism. Macmillan International Higher Education.
11. Kmiec, D., & Longo, B. (2017). The IEEE Guide to Writing in the Engineering and Technical Fields. John Wiley & Sons.
12. Publications, C. (2020). Chicago Manual of Style (CMOS) Guidelines in Tables (Quick Study CMOS). Creative Cloud Publications.
13. Turabian, K., L. (2018). A Manual for Writers of Research Papers, Theses, and Dissertations, Ninth Edition. University of Chicago Press.
14. Islam, M. (2015). A Manual of Style and Standards in Academic Writing, Editing and Publishing. Partridge Publishing Singapore.
15. Saha, L., J., & Dworkin, A., Gary. (2009). International Handbook of Research on Teachers and Teaching. Springer Science & Business Media.
16. Turabian, K. L. (2018). A Manual for Writers of Research Papers, Theses, and Dissertations, Ninth Edition. University of Chicago Press.
17. APA Style. Retrieved September 22, 2020, from https://apastyle.apa.org/
18. American Psychological Association (2010). *Publication manual of the American*
19. *Psychological Association*. Washington.
20. Barnard, C., & Lucas, J. (2001). Editorial Reference citation style. *Animal Behaviour*, 61(6), 1049. https://doi.org/10.1006/anbe.2001.1769
21. Best, J. W., & Kahn, J. V. (1986). *Research in education*. Englewood Cliffs, N.J.: Prentice-Hall.
22. Burger, M. (1992). *Reference techniques* (8th Ed.). Pretoria, South Africa: University of South Africa.
23. Camano-Puig, R., & Pique-Noguera, C. (2009). Referencing Styles and Research. *Nurse Author & Editor*, 19(3), 1–3. https://doi.org/10.1111/j.1750-4910.2009.tb00098.x
24. Draciimann, A. G. (1950). Footnotes and Bibliography. *Libri*, 1(1). https://doi.org/10.1515/libr.1950.1.1.362
25. Fergusson, D. (2009). Inappropriate referencing in research. *BMJ*, 339(jul20 3), b2049–b2049. https://doi.org/10.1136/bmj.b2049
26. Guido, J. F. (1975). Readings in Descriptive Bibliography (Book Review); Bibliography Old & New (Book Review). *College & Research Libraries*, 36(3), 234–235. https://doi.org/10.5860/crl_36_03_234
27. Hacker, D., Sommers, N. I., & Carbajal, M. (2011). *A writer's reference*. Boston ; New York: Bedford/St. Martins.
28. Li, P., & Cunningham, K. (2005). The APA Style Converter: A Web-based interface for converting articles to APA style for publication. *Behavior Research Methods*, 37(2), 219–223. https://doi.org/10.3758/bf03192689
29. Khailova, L. (2014). Selected reference sources in disability studies: an annotated bibliography. *Reference Reviews*, 28(8), 2–6. https://doi.org/10.1108/rr-01-2014-0012
30. Pickles, P. (2011). Endnotes. *Journal of Analytical Psychology*, 56(5), 708–711. https://doi.org/10.1111/j.1468-5922.2011.01941.x
31. Publications, C. (2020). Quick student guide to the APA referencing style. Creative Cloud Publications.
32. Publications, C. (2020a). Quick guide to the MLA referencing style. Creative Cloud Publications.
33. University of Chicago. Press. (2003). the Chicago Manual of Style. Chicago : University of Chicago Press.

ISBN: 978-93-90847-07-5

Chapter - 8 : Qualitative Research: A Methodological Understanding

Soumyashree Sarkar

Independent Research Scholar, Kolkata, West Bengal.

8.1 Introduction:

The onset of COVID 19 outbreak has changed the entire educational system in the world with Assam as no exception. The entire educational system has moved to 100 percent online mode overnight. The online education has started in each and every part of India because of the nationwide lockdown in end of March 2020 and it still continues till date (September 2020). This paper reflects he educational situation in Assam during and post pandemic COVID 19. The study has been conducted with the help of both primary and secondary sources of data. The study found that though many students are getting online classes to enhance their knowledge, there are many who are left out in this crisis time as they do not have access to internet and smart phone.

Research is a technical and creative procedure that people undertake in order to find out things in a systematic way, thereby satisfying their knowledge. The purpose of research is to share some new facts to existing human knowledge base by new discoveries by the researcher. The fact of the matter is that researcher goes beyond the process of simply gathering sheer information. Research is a finer aspect of academics engaged in logical, in-depth, planned and systematic investigation of a particular problem. The term "research" is derived from the French "recherché", which means "to go about seeking". John W. Creswell, states "research is a process of steps used to collect and analyse information to increase our understanding of a topic or issue." The three steps involved in such process are mainly posing a question, collecting the relevant data and required information and facts for answering the same and finally to formulate and present an answer to the readers. Of the various forms of research that have been widely practiced, this chapter seeks to discuss and detail the Qualitative Research technique, the various modalities and aspects associated with it.

Qualitative research is a particular aspect of research that seeks to understand, describe and sometimes explain social phenomenon by analyzing knowledge, accounts and stories by any simple but in depth approach of interaction and communication, observation or recording of facts. The condition of such research should be entirely naturalistic in nature and the researcher should be intimately involved in the entire process.

Tracing its roots to Phenomenology or Symbolic Interactionism, Qualitative research is also called Social Constructivism research. This type of research experienced a steady growth since the 1960s, starting with the emergence of the approaches from a symbolic interactionist perspective (Becker et al., 1961) and the development of grounded theory (Glaser and Strauss, 1967). The researchers undertaking this type of research often consider themselves 'instruments' in the research process, for the observations and interpretations of the world they are dealing with often gets filtered through their own personal lens.

Basically subjective in nature, qualitative research deals with the meanings inductively derived from the up close and personal and social interaction with the human community being studied.

While the methodology is expected in terms of such research to centre on the approaches, modulations and interpretations on the way in which human beings made sense of their subjective reality, attaching meaning to it. In the same way, a thorough explanation of the choices and steps undertaken to collect and analyse the said data is also to be illuminated, for the purpose of validating the research.

8.1.1 Characteristics of Qualitative Research:

a. **Naturalistic Setting:** This is perhaps the most important aspect of a Qualitative Research because natural environment is best for the collection of the data. Artificial or created environment can infiltrate through the smooth functioning and hamper the research process.
b. **Employing Varied Research Methods:** The researchers are free and flexible to use any research method or methods as per his convenience to acquire the desired data. He can use Focus Group Discussions, face to face interviews, phenomenology, content analysis or the like as and when required.
c. **Decipher Participant's Meaning and Context:** The researcher should be fully aware of the context in which he is performing his research study and has to be adequately suave in analyzing their wordings, gestures or expressions. Everything that a researcher finds relevant, starting from verbal wordings to facial expressions should be taken into account and noted down.
d. **Flexible Nature:** Qualitative Research is known to be flexible and can change its dimensions during the course of the research process.
e. **Recursive Approach:** 'Recursively' allows the researcher to change his research design during the ongoing process of the research. In case of qualitative research, data are collected repeatedly, until the specific conditions are met or the researcher attains a saturation level.
f. **Purposeful Sampling:** Qualitative Research calls for the purposeful sampling, where the researcher choses his population on the basis of his convenience, availability of information and resources and fulfilment of purpose.
g. **Unobtrusive:** Sometimes qualitative researchers may employ unobtrusive research methodology, where the researcher need not do any interaction with the human beings but still can collect adequate amount of information by studying and analyzing their letters, messages, video calls, personal mails or the alike. Instead of establishing a direct communication, the indirect data collected can be potential sources of information for the unobtrusive researcher.
h. **Holistic Perspective:** Qualitative research is wholesome in nature and takes into account all the dimensions or aspects that concerns a particular research problem.

8.1.2 Role of the Researcher:

a. **Naturalistic setting to be maintained:** while visiting a particular field for the purpose of data collection, the researcher should in no way create an artificial situation by letting his arrival known beforehand or by any other means which disturbs the free flow of the participants to be studied.

b. **Openness:** the researcher should know to behave as any normal individual, accept rewards and rebukes alike and not be manipulative or overwhelmingly subjective while penning down facts and produce whatever data is obtained as it is.
c. **Rapport Establishing:** the researcher has to strike a good and efficient rapport and friendship with his or her participants under study, for proper communication, cooperation and deliverance of facts.

8.2 Research Questions for Qualitative Research:

Since Qualitative Research is a reflective process, in which the researcher adapts his or her approach based on the participant's response, the questions also changes in the course of the study. Qualitative research questions need to articulate what the researcher wants to know about the intentions and perspectives of those involved in social interactions. The four types of research questions are listed as below:

- **Exploratory Question:** such type of questions are asked to know more about a topic or investigate facts about a phenomenon that has little information otherwise.
- **Explanatory Question:** the questions asked to participants for detailed explanation or description of a particular incident or phenomenon around which the researcher's interest area is likely to revolve.
- **Descriptive Question:** such questions are basically asked to narrate a phenomenon to get a detailed grasp of the concerning causes associated with it.
- **Emancipatory Question:** such questions are asked o the participants which are meant for them to engage in social action around the phenomenon involving them. Example - Paulo Friere's influential work on conscientization (Freire, 1972, p.77), defined as "the process of developing a critical awareness of one's social reality through reflection and action."

8.2.1 Qualitative Research Instruments:

A research instrument is a significant measurement tool employed by the researcher to collect, measure and analyse data relating to the subject under study.

The importance of a research tool lies in the fact of validating a particular data collected coupled with the reliability factor, which otherwise falls meaningless and insignificant in determining further analysis and derivation relating to the further findings of the study. The instruments of qualitative research are as follows-

- **Participant Observation:** a particular researcher sometimes watch the sample under consideration performing some actions and try to discover the meanings people attach on the performance of their actions. Under such kind of information, the researcher attempts to fully participate and becomes a part of the lives and activities of the social community and its members. This enables the researcher to share accurate information about the events, circumstances, life styles, problems, discourse, habits or feelings of the studied samples instead of maintaining a distant observer's code. The observer in such case can genuinely feel the intricate issues and prepare his report exhaustively.
- **Enquiry i**n **Depth**: the researcher collects information on all aspect and sources until he or she is fully satisfied about the issues concerning his or her said study. It is always necessary for the investigator to reach a saturation point regarding the research question

at hand by the process of enquiry and re-enquiry, for preparing the report with the maximum range of detailed information available.

- **Unstructured Interviewing:** unstructured or non-directive interviews are such in which the questions to be asked are not scheduled beforehand or pre-planned. While entering the field of investigation, anything that comes to the mind of the researcher by seeing or observing something new or unpredictable, can be enquired immediately. Qualitative research also accommodates Structured Interviews in some cases, but on an analytic basis, unstructured interviews re found to be the best in this regard.
- **Focus Group Discussion (FGD):** in order to understand an issue at a deeper level, FGDs are very helpful. FGDs are predetermined semi-structured interviews where a skilled moderator induces a particular topic to generate a discussion among the participant themselves. Usually comprised of seven to ten people in an ideal group, everybody should be allowed to give their views and the researcher should have a recording instrument to record the elicited responses.
- **Open Ended Questionnaires:** such questions are highly subjective with no strict 'yes' or 'no'. This research technique relies heavily on giving explanatory or descriptive answer to a particular questionnaire by a researcher, with room for further probing by the response given by the respondent. Example- a questionnaire circulated to ten teachers asking them to write down about the day to day happenings of a particular rural school.
- **Documents, Videos and Tape Recorders:** this is the best instrument for collecting and recording authentic data as the information collected through field notes in a hurry may sometimes fail to provide the actual impact of the contemporary circumstances later, when the researcher sits down to develop and analyse on the collected data.

8.2.2 Methods of Qualitative Research:

The different research approaches that qualitative researchers use to collect information in a naturalistic setting are mentioned and elaborated hereby.

a. Narrative Research: In order to get specific insights into the life cycle of an individual, such type of research is undertaken. Narrative Research narrates the life of an individual by exploring their life cycle in detail. For example, a researcher goes on his way to collect information and study the life structure, behavior, food habits, day to day habits, attitude, interest areas, psychological bent of mind, likes or dislikes, love for sports and games of a particular person or group and reporting it likewise. It is basically the in depth study of human sciences. The collection of such intricate details from a group or individual and elaborating it through narration also requires much strenuous and skilled effort on the part of the researcher.

b. Phenomenology: This method attempts to understand or explain the life experiences or consciousness about the respondents regarding a particular event or phenomenon. For example, a person is asked about his or her perception regarding a near one's demise in the family. The primary objective regarding phenomenology is to get hold of the description and explanation of the phenomena as consciously experienced by the participant.

c. Field Research: Field Research employs the collection of raw data in a naturalistic setting by means of informal interviews, participant observation, collective discussions, or analysis of personal documents produced within the group. For example, social scientists would conduct their research proceedings in a natural setting to know more about the

culture, taste, customs, language, habits or social structure of a particular ethnic population.

d. Grounded Theory: This theory investigates a process, action or interaction with the goal of developing a theory grounded in observations. Grounded theory basically focusses in building a theory by creating meaning from the data. It can use multiple types of data and provide an in depth perspective. By coding the collected data into categories, new theories can also emerge. All the data should be collected at the ground level and then be divided into three parts-

- **Initial Coding:** The first round of collected information is to be put into categories. This step involves the production of initial codes from the collected data and assigning them into particular themes. The aspects of the data which are repeated are collected and put under their respective themes.
- **Axial Coding:** This stage involves the re-reading of the data and to find out whether any significant category is left out or needs to be added.
- **Final Coding:** In case of final coding, the researcher needs to revisit the population from whom information are taken innumerable times till he feels that no additional information is missed out by him or her. In other words, the researcher should have complete data saturation whereby he or she would feel to stop the investigation. Example- Psychologists like B.F Skinner or Edward Thorndike established their respective theories after repeated exercise.

e. Ethnography: This type of research originates from the academic disciplines of anthropology or sociology. A distinct cultural group of population is usually studied and the personal entry into the group on the part of the researcher is usually to be done through a gatekeeper. The process of collecting the required data is to be done in a complete immersive way. The anthropologist enters and spends a significant amount of time in the real environment which is needed to be observed. The participants are to be observed in their real life settings without causing any disruption to their normal moves. Both emic (from the perspective of the subject) and etic (from the perspective of the observer) perspectives of the individual's mind have to be taken care of for the ethnographic study to be valid and solid. For example, there is a particular instance of a researcher, Daniel, marrying and staying in an ethnic group for twenty five years to know and study the culture, habits and dispositions of a tribal village in East India.

f. Case Study: Case studies are very common approaches in psychological researches where they are used to answer the how or why questions when the researcher has little control over the events. It is simply the study of a case within the real life. It examines the episodic events or develop an in depth analysis of single or multiple cases on a particular issue and derive a conclusion. Example- a researcher undertakes a case study about the probable causes of maladjustment of a differently abled child in his classroom.

8.2.3 Approaches of Qualitative Research:

The qualitative research can be divided into the following categories.

a. Discourse Analysis: Discourse Analysis refers to a process where by analyzing the discourse of the speaker, we can understand, interpret and give meaning to the intentions of the speaker or samples under study. While discourse is just about studying the words, analysis is about adding or subtracting them in order to derive a meaningful concept. While undergoing a research, the main aim is to identify dominant discourses and analyse it skillfully. Besides words, discourses can also be in the form of pictures, talks or texts.

b. **Conversation and Event or Micro Analysis:** Conversation Analysis originated as an approach to the study of the social organization of everyday conduct. It focusses on how individuals in social settings engage in meaningful acts through language and make sense of the world around them.
c. **Narrative Analysis:** Since narratives are the easiest way to create, recreate, analyse and grasp, narrative analysis is a prominent method in research methodology in unfolding patterns of behavior or life style of a group or community in a lucid and interesting way. Narrative research is not a singular approach; rather, it refers to a range of ways in examining the role of storytelling in understanding the identity and social life (Riessman, 2008).
d. **Document Analysis:** Document Analysis is a social research method which involves a lot of reading. It identifies and interprets patterns in a data and classifies them. In the application of a document analysis, the data is useful, comprehensive and flawless, which can be collected at different time periods by in depth study of the documentations available at hand.
e. **Content Analysis:** a mode of research that does not collect data directly from the people. Content Analysis is typically the study of recorded human communications such as books, websites, videos, messages or tweets, where the researcher can frame a finding based on such already existing informative sources.

8.2.4 Steps of Qualitative Research:

Since qualitative research acknowledges a subjective element in the research process, it generally seeks to collect an in depth insight into the modalities of the human behavior by analyzing words, pictures, recorded data collected in a natural setting through the course of the research process and generate findings on the basis of that, which paves the way for his final research report. Some of the steps of the qualitative research design are as follows:

a. **Select Research Topic:** The crucial phase for a researcher when he has to keep a number of factors into consideration while deciding on the topic of his or her research. The research topic should be decided upon by doing a lot of background study about the matter at hand. Not too common or too controversial topic should be selected. The areas of public interest where the researcher feels might be a gap, despite of previous research may be undertaken or such topics may be chosen which may be of major help to the community at large.
   The topic should be such that the researcher might be committed to it throughout the process and be honest and ethical in all sort of data collecting procedures, so that the original perspectives be reflected in his work.
b. **Determine Research Questions:** Good and effective research questions can navigate the research paper smoothly. The research questions should centre on the research problem. The research questions illuminates and highlights the main motif behind the conduction of the research.
c. **Set Resign and Instrument of the Study:** A researcher should have a well-planned design about the ways in which he is to go about while he is undertaking his research.

The population he is to study in order to gather information for his research purpose has to be determined. The tools and instruments he has to employ for the purpose of data collection has also to be thought out by him so as to carry about his research procedures smoothly.

d. Collect Data from the Field: In case of qualitative research, the data collection is a crucial aspect because the researcher has to play a vital part in collecting first-hand information by intricately being involved in the process.

e. Analyse Data: The various sets of random data which are collected by the researcher in the course of the field study are coded and categorized, until the researcher finds a direction about their analysis. While analyzing, the researcher should not be biased or manipulative and should always produce original findings.

f. Generate Findings: The analysed data can take the form of findings, which he researcher can generate after the successful completion of the analysed data.

g. Validate Findings: the researcher can check the validity of the results by running pilot test or by checking the internal consistency of the collected data. Validating the research findings is a must for the purpose of genuineness and authentication of the detailed result.

h. Write Research Report: The completion of the above steps allows the researcher to write the research report, whereby he explains and justifies his research findings and make it understandable.

8.2.5 Some Criteria for Judging Qualitative Research:

a. Credibility or Truth Value: the most pertinent question that looms the mind of the readers is that how credible are the findings or can the findings of the researcher be trusted at all. The question as to whether something is hidden, falsely put or manipulated is an issue which is constantly in operation. The authenticity or the trustworthiness of the research reports should not be debatable at any cost.

b. Dependability or Consistency: Once a research about a particular issue in a particular place is conducted, how sure we can be that the findings of the research would be replicated if the study were to be conducted with the same participants in the same context, is also an issue to be thought about. Example – If three researchers visiting the same place in three different times collects the same data, and every time if the collected data is found to be somewhat similar, then the research can be said to have consistency.

c. Transferability or Applicability: while a research report is being presented, we should also look into the fact as how applicable are the findings of that research to another setting or group of people.

d. Conformability or Neutrality: while reading and judging a research finding, we should also be assured as to how far the findings of that research reflect a natural setting rather than the creation of the researcher's bias or prejudices.

8.2.6 Researcher's Role in Validating Qualitative Research:

a. Inclusion of the Primary Data in the Final Report: A researcher should not leave out bits and pieces of information he has acquired in his data collection process, and rather produce them diligently in his final report so as to remain clear and unquestionable.

b. The Researcher Should be Expressive: Any personal feeling or occurrence that the researcher came across during the data collection should be candidly expressed by the researcher, if it is of utmost relevance. This may help the readers to easily grasp the content and the scenario of the research study.

c. Balance: A balance should be struck between what the researcher's explanation of what was perceived by him as important and what is actually important that has been found out through the research proceedings. Such real and significant areas should be reflected adequately in his course of explanation.

d. Seek Professional Feedback: The researcher should arrange and allow scrutiny of his research manuscript by his colleagues and seniors, for proper judgment and error free progression of his work.

e. Write Accurately: proper sentence construction, lucid language, avoidance of double meaning words, correct words should be used in the illustration of the research report.

8.2.7 Triangulation of Data:

Triangulation refers to a process where the researcher analyses the same situation from multiple angles or whereby he uses multiple methods or data sources to study the same phenomenon. Triangulation of data is a very important aspect in qualitative research. Dezin (1978) has identified several types of triangulation.

a. Data Triangulation: If the qualitative research report has to be authentic or acceptable to others, an opportunity for proper data triangulation must be given. For example, the same person sometimes undergoes two or three modalities for giving the same information. Once even if the data is collected from the person through questionnaire, the same data has to be collected from the same person via Interview. After one month or after a certain time lapse, the same data needs to be collected from the same participant or group of participants by using any other tool, to ensure whether the respondent has changed his or her mind in the course of time.

b. Investigator Triangulation: In a research study, when more than one field investigator is involved, and each one has undergone the same category of training, each investigator must give similar ideas regarding the collected data, failing which there would be clear indication of some sort of problem area which is yet to get settled.

c. Theory Triangulation: During the course of investigation, any theory that a researcher comes across, needs to be properly triangulated. For example a researcher gets a data that a particular village is subjected to repeated theft issue. In order to ensure that the said information is authentic, the researcher needs to call different persons like the police personnel, village politicians, club members, district officials, the villagers, the local market shops and several other related persons regarding a particular issue, before coming to a conclusion that the theory which was propagated is authentic, correct, approved and final.

d. Methodological Triangulation: A researcher needs to be very authentic in his approach as to the methods and modalities he is to adopt, while collecting a data to establish a fact.

e. Analysis Triangulation: Analysis Triangulation may be descriptive but sometimes graphical triangulation may be given. Qualitative analysis may not always call for ANOVA or ANCOVA, but small numerical figures of statistical representation can be given at times, in order to make the findings understandable to the reader.

8.2.8 Advantages of Qualitative Research:

- The researcher in a qualitative research gains a deeper and rich understanding of the people and events in a naturalistic setting. The findings, therefore, are ecologically valid.
- Qualitative researchers allows the respondents to express themselves freely rather than expressing their opinions to structured questions. Qualitative researchers always invites spontaneous responses from the participants of their study.

- Qualitative research produces more in depth and comprehensive information of the situation under study. An intricate analysis detailing the facts and responses are produced.
- Qualitative research seeks a wide and vivid understanding of the entire situation.
- Unlike other research designs, qualitative research allows a lot of flexibility to the researcher.

8.2.9 Limitations of Qualitative Research:

Like every other research method, qualitative research design also comes up with certain limitations, as follows:

a. The research report faces the problem of too much subjectivity at times. Despite of validating the research by various means, there always lies the risk of manipulation of the data or the biasness of the researcher.
b. While going through the research report, it sometimes become very difficult for the readers to detect researcher's induced bias and get a genuine picture of the issue he wants to study.
c. The scope of such type of research is limited, for it requires in-depth comprehensive data gathering approaches.
d. The method of data collection in case of qualitative research is time consuming and taxing. It becomes very difficult at times to ascertain when the saturation is reached.

8.3 Use of Software in Qualitative Data Analysis:

Since the researcher has to struggle down with a vast source of transcription and notes in case of qualitative research, he often gets juggled up about the proper placement and setting of his collected data. The qualitative data analysis software makes the research process easier and methodical for the researcher. Tools are used to assist the researcher with transcription analysis, coding, recursive abstraction, text interpretation, content analysis, discourse analysis and grounded theory methodology. Some rated and widely used qualitative data analysis software are NVivo, ATLAS.ti, Provalis Research Text Analytics Software, Quirkos, MAXQDA, Qiqqa, webQDA, Hyper RESEARCH, Transana and F4analyse.

8.4 References:

1. Berg, B.L. (2012). *Research Methods Qualitative for the Social Science*. (8th Ed). Long Beach: Allyn and Bacon.
2. Cohen, L et al (2007) *Research Methods in Education*. London. Routledge.
3. Creswell J.W. (1998) *Qualitative Inquiry and research design*. Thousand Oaks. Sage Publications.
4. Denzin, N.K. (1978). *Sociological Methods.* New York: Mc Graw-Hill.
5. Denzin, N.K., Lincoln, Y.S. (Eds). (1994). '*Handbook of Qualitative research'.* Thousand Oaks, CA: Sage Publications.
6. Drobot, L. (2012) "*Qualitative Research in Social Sciences and Education-Basic Paradigms and research methods".* Research in Pedagogy. 2 (2), 11-20.
7. Emerson, R.M., Fretz, R.I., & Shaw, L.L. (2011). *Writing Ethnographic Fieldnotes*. University of Chicago Press.

8. Freeman, M., de Marrias, K., Preissle, J., Roulston, K., Pierre, E.A. (2007). 'Standards of evidence in qualitative research; an incitement to discourse.' *Educational Researcher,* 36(1); 25-32.
9. Gupta, R. K., Mukhopadhay, S. (2014). 'Survey of qualitative Research Methodology in strategy Research and Implication for Indian Researcher.' *Vision: The Journal of Business Perspective.* Sage Publications.
10. Johnson, L. R. (2017) *Community based Qualitative Research: Approaches for Education and the Social Sciences*. Sage Publications.
11. Maynard, K., & Caahnmann-Taylor, M (2010). Anthropology at the Edge of words: Where Poetry and Ethnography Meet. *Anthropology and Humanism,* 35(1), 2-19.
12. Merriam, S. B. & Tisdell, E. J. *'Qualitative Research: A Guide to Design and Implication.'* (Fourth Edition.) Wiley Publishers.
13. Patton, M.Q. (2001). *'Qualitative Evaluation and Research Methods.'* (2nd Edition). Thousand Oaks, CA: Sage Publications.
14. Prasad, A., Prasad, P. (2002). 'The coming age of interpretive organizational Research.' *Organizational Research Methods.*
15. Saldana, J. (2013). *'The Coding Manual for Qualitative Researchers.'* (Second Edition.) Sage Publications.
16. Seale, C. (1999). '*The quality of qualitative research.'* London: SAGE Publications. Google Scholar.
17. Simons, H. (2009). *Case Study Research in Practice*. Sage, London.
18. Strauss, A. L (1987) *Qualitative Analysis for Social Scientists*. Cambridge: Cambridge University Press.
19. Strauss and Corbin J. (1990) *Basis of Qualitative Research: Grounded Theory Procedures and Techniques.* Newbury Park, CA. Sage Publications.
20. Thompson, B. and Synder, P.A. (1997) Statistical significance testing practices. *Journal of Experimental Education,* 66, 75-83.
21. Tuff our, I. (2017). A Critical Overview of Interpretative Phenomenological Analysis: A Contemporary Qualitative Research Approach. *Journal of Healthcare Communications.* 2(4), 52(1)-52(5).
22. Walia, R. (2015). A Saga of Qualitative Research. *Social Criminal,* 5 (2), 124.
23. Wolcott, H. (2009). *Writing up Qualitative Research* (3rd Edition). Thousand Oaks, Sage.

ISBN: 978-93-90847-07-5

Chapter - 9 : Qualitative Research

Suneeta Khanna Ganguly

Assistance Professor, Department of Psychology, Handique Girls College, Guwahati.

9.1 Qualitative Research:

Qualitative research is a type of scientific research. It seeks to understand a given research problem or topic from the perspectives of the local population it involves.

Qualitative research is especially effective in obtaining culturally specific information about the values, opinions, behaviors, and social contexts of particular populations.

The strength of qualitative research is its ability to provide complex textual descriptions of how people experience a given research issue. It provides information about the "human" side of an issue – that is, the often contradictory behaviors, beliefs, opinions, emotions, and relationships of individuals.

Qualitative methods are also effective in identifying intangible factors, such as social norms, socioeconomic status, gender roles, ethnicity, and religion, whose role in the research issue may not be readily apparent.

When used along with quantitative methods, qualitative research can help us to interpret and better understand the complex reality of a given situation and the implications of quantitative data.

Qualitative researchers are interested in understanding the meaning people have constructed, that is, how people make sense of their world and the experiences they have in the world. (Merriam, 2009, p. 13)

In general terms, scientific research consists of an investigation that:

- seeks answers to a question
- systematically uses a predefined set of procedures to answer the question
- collects evidence
- produces findings that were not determined in advance
- produces findings that are applicable beyond the immediate boundaries of the study

Although findings from qualitative data can often be extended to people with characteristics similar to those in the study population, gaining a rich and complex understanding of a specific social context or phenomenon typically takes precedence over eliciting data that can be generalized to other geographical areas or populations.

In this sense, qualitative research differs slightly from scientific research in general.

9.2 Characteristics of Qualitative Research:

Qualitative Research	Qualitative Research
Uses words	Uses numbers
Concerned with meanings	Concerned with behavior
Induces hypotheses from data	Begins with hypotheses
Case studies	Generalization

Source: adapted from Hammersley, 1992

- **Quantitative researchers** clearly use words as well as numbers. For instance, they usually offer verbal interpretations of their statistical tables. It is also not true that numbers are absent from qualitative research. Having discovered some phenomenon by qualitative means, there is every reason to see how frequently it occurs.
- **Quantitative research** is often concerned with meanings – questionnaires or surveys are commonly designed to establish how people 'see' themselves or others. **Qualitative researchers** can be interested in behavior just as much as how people see things. Many qualitative studies examine how people interact with one another in particular settings like the workplace, a museum or an auction.
- The standard, published **quantitative study** usually does begin with a hypothesis which it then seeks to test. However, it is becoming more common for **qualitative researchers** to begin with a hypothesis.
- In **Quantitative research** they generalizes the information and infer it accordingly, whereas in qualitative research they literally focuses on the single case study or group cases.
- In **qualitative research** they are used to gather information at the location where the respondents usually experience problems. This is real-time information that forces the participants to come out of their geographic environment to assemble it.
- **Qualitative researchers** do not just focus on a single source of data. Instead, they collect data from different sources like interviews, observations, and documents.
- They also work to solve complicated problems by breaking them down into useful inferences. It makes it simple to understand and read.
- Lastly, such communicative methods can lead people to easily build their trust in the researcher.

9.3 Claimed Features of Qualitative and Quantitative Method:

Qualitative	Quantitative
Soft	hard
Flexible	Fived
Subjective	Objective
Political	Value-free
Case study	Survey
Speculative	Hypothesis testing
Grounded	Abstract

Source: Halfpenny, 1979: 799

9.3.1 Research Approaches and Implications for Data Collection:

Type of Approach	Defining Features	Data Collection Implications
Phenomenology	Focuses on individual experiences, beliefs, and perceptions. · Text used as a proxy for human experience	Questions and observations are aimed at drawing out individual experiences and perceptions. In focus groups, group experiences and normative perceptions are typically sought out. In-depth interviews and focus groups are ideal methods for collecting phenomenological data
Ethnography	Oriented toward studying shared meanings and practices (i.e., culture). Emphasizes the emic perspective. Can have a contemporary or historical focus.	Questions and observations are generally related to social and cultural processes and shared meanings within a given group of people. Traditionally, it is associated with long-term fieldwork, but some aspects are employed in applied settings. Participant observation is well suited to ethnographic inquiry
Inductive Thematic Analysis	Draws on inductive analytic methods (this would be same for Grounded Theory below as well). Involves identifying and coding emergent themes within data.	Most common analytic approach used in qualitative inquiry. ITA requires generation of free-flowing data. In-depth interviews and focus groups are the most common data collection techniques associated with ITA Notes from participant observation activities can be analyzed using ITA, but interview/focus group data are better
Grounded Theory	Inductive data collection and analytic methods. Uses systematic and exhaustive comparison of text segments to build thematic structure and theory from a body of text.	As above, in-depth interviews and focus groups are the most common data collection techniques associated with GT. Sample sizes for grounded theory are more limited than for ITA because the analytic process is more intensive and time consuming.

Type of Approach	Defining Features	Data Collection Implications
	Common analytic approach in qualitative studies.	Note: Many researchers incorrectly label all inductive thematic analyses "grounded theory," as a default. Technically, they are not the same thing.
Case Study	Analysis of one to several cases that are unique with respect to the research topic Analysis primarily focused on exploring the unique quality.	Cases are selected based on a unique (often rarely observed) quality. Questions and observations should focus on, and delve deeply into, the unique feature of interest.
Discourse/ Conversation Analysis	Study of "naturally occurring" discourse Can range from conversation to public events to existing documents. Text and structures within discourse used as objects of analysis.	These linguistically focused methods often use existing documents as data. Conversations between individuals that spontaneously emerge within group interviews or focus groups may be studied but are not preferred. Participant observation is conducive to discourse analysis if narratives from public events can be recorded.
Narrative Analysis	Narratives (storytelling) used as source of data. Narratives from one or more sources (e.g., interviews, literature, letters, diaries).	If generating narratives (through in-depth interviews), then questions/ tasks need to be aimed at eliciting stories and the importance those stories, hold for participants, as well as larger cultural meaning
Mixed Methods	Defined as integrating quantitative and qualitative research methods in one study. Two most common designs are sequential and concurrent.	Collection of qualitative data in a mixed methods study can be informed from a wide range of theoretical perspectives and analytic approaches. Researchers must specify up front, and in detail, how, when, and why qualitative and quantitative datasets will be integrated.

9.4 Types of Qualitative Research:

Have a look at the table below. It compares the five types of qualitative research in terms of focus, sample size, and the method of data collection.

Type	Focus	Sample Size	Data Collection Method
Ethnographic Approach	Culture	_	Observations and Interviews
Narrative Approach	Individual experience	1-2	Individual's stories and existing documents
Phenomenological Model	People involved	5-25	In-depth Interviews
Grounded Theory	To build a theory	20-50	Identifying relationships after interviews
Case Studies	Entity, event, or organization	–	Interviews, observation, focus group, documents, and reports

9.4.1 Sampling in Qualitative Research:

Even if it were possible, it is not necessary to collect data from everyone in a community in order to get valid findings. In qualitative research, only a sample (that is, a subset) of a population is selected for any given study. The study's research objectives and the characteristics of the study population (such as size and diversity) determine which and how many people to select. There are three most common sampling methods used in qualitative research:

- Purposive sampling,
- Quota sampling, and
- Snowball sampling.

Purposive Sampling: one of the most common sampling strategies, group's participants according to preselected criteria relevant to a particular research question (for example, HIV-positive women in Capital City). Sample sizes, which may or may not be fixed prior to data collection, depend on the resources and time available, as well as the study's objectives. Purposive sample sizes are often determined on the basis of theoretical saturation (the point in data collection when new data no longer bring additional insights to the research questions). Purposive sampling is therefore most successful when data review and analysis are done in conjunction with data collection.

Quota Sampling: sometimes considered a type of purposive sampling, is also common. In quota sampling, we decide while designing the study how many people with which characteristics to include as participants. Characteristics might include age, place of residence, gender, class, profession, marital status, use of a particular contraceptive method, HIV status, etc. The criteria we choose allow us to focus on people we think would be most likely to experience, know about, or have insights into the research topic. Then we go into the community and – using recruitment strategies appropriate to the location, culture, and study population – find people who fit these criteria, until we meet the prescribed quotas.

A Third Type of Sampling Snowballing: also known as chain referral sampling – is considered a type of purposive sampling. In this method, participants or informants with whom contact has already been made use their social networks to refer the researcher to other people

who could potentially. Snowball sampling is often used to find and recruit "hidden populations," that is, groups not easily accessible to researchers through other sampling strategies.

9.4.2 Methods of Qualitative Research:

Qualitative research methods reveal the attitude of the target audience with reference to a particular topic. They basically originate from behavioral and social science. Moreover, it presents detailed outcomes and the inferences can be described easily from the data analysis. The most commonly used qualitative methods are:

- In –dept Interviews
- Observation
- Case Study
- Record Keeping
- Content Analysis
- Focus Groups

The details are as follows:

A. In-Depth Interviews:

Organizing in-depth interviews is the most common method for qualitative research. It is a conversational method that involves one participant at a time. The benefits of this approach include collecting data about what people believe and what their motivations are. Such interviews can be conducted face-to-face or on the telephone. However, it can last from half an hour to two hours. Lastly, it provides a better idea of the respondent's body language. The in-depth interview is one of the most common types of qualitative research methods out there. It involves a personal interview with a single respondent. This method provides a great opportunity to capture rich, descriptive data about people's behaviors, motivations, beliefs and etc. You can use the in-depth interview as an individual research method or as part of a multi-method design. Depth interviews are typically performed face to face or by phone. In addition, you can pay attention to the body language of the respondent to understand better his/her answers. Interviewing takes time to organize it. The interview might take between half an hour to two hours or even more.

Observation:

It's a mechanism using empirical methodologies to collect systematic sources of data. Primarily, a participant is used to compare differences. This includes five essential sensory organs and their functions i.e.

- Sight
- Taste
- Hearing
- Smell
- Touch

B. Focus Groups:

A focus group involves a limited number of participants used for data collection. Such a target audience is there to find the responses to ‘what', ‘how', and ‘why' questions. Moreover, it does not require a researcher to necessarily communicate with the group directly. Instead, online surveys can be sent on several devices to collect the answers. This method is considered expensive in contrast to other qualitative research methods. Nevertheless, it is useful when it comes to market research and testing of new products.

A focus group is also among the most common types of qualitative research methods used in marketing data collection. A focus group normally includes a limited number of participants (around 6 to 12 from) within your target market. This research technique collects data through group interaction. A researcher leads a discussion amongst the group where the participants share lifestyle, needs or behavioral characteristics.

Focus groups aim to find an answer of why, what, and how questions. This research design need not be in person. Nowadays, focus groups can be hosted by several platforms. Focus groups are an expensive method of qualitative research. Typical they are used to explain complex processes from the basics, to identify customer motives and needs (where a complex interaction of factors presence), to identify how products are used and etc.

C. Case Study:

This method has advanced over the past few years. It is mainly used within a number of areas to explain an organization or an entity, business, or situation. A case study is in-depth research of a particular situation or event. This approach growing in the recent years because it is based on real-world experiences. Case study research methodology is used within a number of disciplines including education, social sciences, business, law, health, and many others. Despite this type of research sounds very easy to perform, it involves a deep understanding of a variety of data sources and types of statistical analysis. In addition, case studies can be qualitative and/or quantitative.

D. Content Analysis:

It is used for studying documents and communication artifacts. Social scientists use it to examine the study pattern in a systematic manner. This method includes interpreting words and images from a variety of documents, music, or other types of media. The researchers aim to find out how the words and images are used, and in what context. This way you can draw and come up with conclusions about the hidden culture and behavior. Nowadays, content analysis in researching digital and social media users is a common technique within the social sciences. The main goals of content analysis include identifying important aspects of the content, presenting them in a clear way, support of some argument and others.

E. Record-Keeping:

It uses reliable existing documents and similar information sources as the data source. To gather relevant data, a researcher may go over books and other reference material. It can be used in a new research study.

F. Action Research:

This is an interesting qualitative research method in which the researcher and recipients have the same characteristics. Action data collection aims to solve a problem and is conducted by individuals working with others as part of a "community of practice". It is a method of problem-solving led by people working with others in teams. Action research is known also as collaborative inquiry, emancipatory research, and contextual action research. Mainly, action research focuses on turning people into researchers.

The assumption is that people learn best when they do the research themselves. It also aims to promote improvement or change by stimulating knowledge sharing activities.

A great example of action research is psychotherapists conducting research to improve their therapeutic practice. This type of research might involve types of field research such as interviews, focus groups, observation, and others.

9.4.3 Comparison of Quantitative and Qualitative Research Approaches:

	Quantitative	**Qualitative**
General framework	Seek to confirm hypotheses about phenomena. Instruments use more rigid style of eliciting and categorizing responses to questions. Use highly structured methods such as questionnaires, surveys, and structured observation	Seek to explore phenomena. Instruments use more flexible, iterative style of eliciting and categorizing responses to questions. Use semi-structured methods such as in-depth interviews, focus groups, and participant observation.
Analytical objectives	To quantify variation. To predict causal relationships. To describe characteristics of a population.	To describe variation. To describe and explain relationships. To describe individual experiences. To describe group norms.
Question format	Close-ended	Open-ended
Data format	Numerical (obtained by assigning numerical values to responses)	Textual (obtained from audiotapes, videotapes, and field notes)
Flexibility in study design	Study design is stable from beginning to end Participant responses do not influence or determine how and	Some aspects of the study are flexible (for example, the addition, exclusion, or wording of particular interview questions)

	Quantitative	Qualitative
	which questions researchers ask next Study design is subject to statistical assumptions and conditions	Participant responses affect how and which questions researchers ask next Study design is iterative, that is, data collection and research questions are adjusted according to what is learned

9.4.4 Ethical Guidelines in Qualitative Research:

The ethical issues relevant to qualitative research. It is intended to provide a context for discussion in subsequent modules of procedures for safeguarding research participants' interests. Qualitative researchers, like anyone conducting research with people, should undergo formal research ethics training. The material presented here is not a substitute for training on research ethics. A list of ethics training resources is included. Research ethics deals primarily with the interaction between researchers and the people they study. Professional ethics deals with additional issues such as collaborative relationships among researchers, mentoring relationships, intellectual property, fabrication of data, and plagiarism, among others. While we do not explicitly discuss professional ethics here, they are obviously as important for qualitative research as for any other endeavor. Most professional organizations, such as the American Anthropological Association, the Society for Applied Anthropology, the American Sociological Association, and the American Public Health Association, have developed broad statements of professional ethics that are easily accessible via the Internet.

9.4.5 Why is Research Ethics Important in Qualitative Research?

The history and development of international research ethics guidance is strongly reflective of abuses and mistakes made in the course of biomedical research. This has led some qualitative researchers to conclude that their research is unlikely to benefit from such guidance or even that they are not at risk of perpetrating abuses or making mistakes of real consequence for the people they study. Conversely, biomedical and public health researchers who use qualitative approaches without having the benefit of formal training in the social sciences may attempt to rigidly enforce bioethics practices without considering whether they are appropriate for qualitative research. Between these two extremes lies a balanced approach founded on established principles for ethical research that are appropriately interpreted for and applied to the qualitative research context. Agreed-upon standards for research ethics help ensure that as researchers we explicitly consider the needs and concerns of the people we study, that appropriate oversight for the conduct of research takes place, and that a basis for trust is established between researchers and study participants. Whenever we conduct research on people, the well-being of research participants must be our top priority.

The research question is always of secondary importance. This means that if a choice must be made between doing harm to a participant and doing harm to the research, it is the research that is sacrificed. Fortunately, choices of that magnitude rarely need to be made in qualitative research! But the principle must not be dismissed as irrelevant, or we can find ourselves making decisions that eventually bring us to the point where our work threatens to disrupt the lives of the people we are researching.

9.5 References:

1. Bernard HR. Research Methods in Anthropology, Second Edition. London: Sage Publications, 1995.
2. Denzin NK, Lincoln YS (Eds.). Handbook of Qualitative Research. London: Sage Publications, 2000.
3. Hammersley, M. (1992) 'Deconstructing the qualitative-quantitative divide', in Brannen, J. (ed.) Mixing Methods: Qualitative and Quantitative Research, Alder shot, and Avebury.
4. Marshall PA. Human subject's protections, institutional review boards, and cultural anthropological research. Anthropol Q 2003; 76(2):269-85.
5. Merriam, S. (2009). Qualitative research: A guide to design and implementation. San Francisco, CA: Jossey-Bass.
6. National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research. The Belmont Report. Ethical Principles and Guidelines for the Protection of Human Subjects of Research. Washington, DC: National Institutes of Health, 1979. Available: http://ohsr.od.nih.gov/guidelines/belmont.html.
7. Weijer C, Golds and G, Emanuel EJ. Protecting communities in research: current guidelines and limits of extrapolation. Nature Genetics 1999; 23 (3):275-80.
8. Halfpenny. P., (1979) The Analysis of Qualitative Data https://doi.org/10.1111/j.1467-954X.1979.tb00361.x

ISBN: 978-93-90847-07-5

Chapter - 10 : A Study on Formulating and Testing Hypothesis

Pooja Kumawat

Assistant Professor in Chemistry, S. R. R. M. Govt. P. G. College, Jhunjhunu (Rajasthan).

Abstract:

The word hypothesis consists of two words: Hypo + thesis = Hypothesis. 'Hypo' means tentative or subject to the verification and 'Thesis' means statement about solution of a problem. The word meaning of the term hypothesis is a tentative statement about the solution of the problem. Hypothesis offers a solution of the problem that is to be verified empirically and based on some rationale.

Another meaning of the word hypothesis which is composed of two words – 'Hypo' means composition of two or more variables which is to be verified. 'Thesis' means position of these variables in the specific frame of reference. This is the operational meaning of the term hypothesis. Hypothesis is the composition of some variables which have some specific position or role of the variables i.e. to be verified empirically. It is a proposition about the factual and conceptual elements. Hypothesis is called a leap into the dark. It is a brilliant guess about the solution of a problem.

Keywords:

Formulating, Testing, Hypothesis, Hypothesis Testing.

10.1 Introduction:

A hypothesis is a tentative statement about the relationship between two or more variables. A hypothesis is a specific, testable prediction about what you expect to happen in your study. To be complete the hypothesis must include three components –

- The variables;
- The population; and
- The relationship between the variables.

Remember, a hypothesis does not have to be correct. While the hypothesis predicts what the researchers expect to see, the goal of research is to determine whether this guess is right or wrong.

10.2 What Is Hypothesis Testing?

Hypothesis testing is an act in statistics whereby an analyst tests an assumption regarding a population parameter. The methodology employed by the analyst depends on the nature of the data used and the reason for the analysis.

Hypothesis testing is used to assess the plausibility of a hypothesis by using sample data. Such data may come from a larger population, or from a data-generating process. The word "population" will be used for both of these cases in the following descriptions.[1]

10.3 Assumption, Postulate and Hypothesis:

A. Assumption: Assumption means taking things for granted so that the situation is simplified for logical procedure. Assumptions are not the very ground of our activity as the postulates are. They merely facilitate the progress of an agreement a partial simplification by introducing restrictive conditions.

B. Postulate: Postulates are the working beliefs of most scientific activity. A postulate is a statement assumed to be true without need of proof of any kind. A postulate states an assumption that we make about some relationship between objects.

C. Hypothesis: A hypothesis is different from both of these. It is the presumptive statement of a proposition which the investigator seeks to prove. It is a condensed generalization.

This generalization requires knowledge of principles of things or essential characteristics which pertain to entire class of phenomena.

The theory when stated as a testable proposition formally and clearly and subjected to empirical or experimental verification is known as hypothesis. [2, 3]

10.4 Nature of Hypothesis:

The hypothesis is a clear statement of what is intended to be investigated. It should be specified before research is conducted and openly stated in reporting the results. This allows to [4]

- the research objectives;
- the key abstract concepts involved in the research; and
- Its relationship to both the problem statement and the literature review.

The following are the main features of a hypothesis –

- Is conceptual in nature.
- Is a verbal statement in a declarative form?
- Has the empirical referent.
- Indicates the tentative relationship between two or more variables.
- Is a powerful tool of advancement of knowledge, consistent with existing knowledge and conducive to further enquiry?
- Can be tested, verifiable or falsifiable.
- Is not moral or ethical questions.
- Is neither too specific nor to general.
- Is a prediction of consequences?
- Is considered valuable even if proven false.

10.5 Functions/ Roles of Hypothesis:

A hypothesis, which is a provisional formulation, plays significant role in empirical or socio-legal research. It not only navigates research in a proper direction but also contributes in testing or suggesting theories and describing a social or legal phenomenon.

Role of hypothesis in navigating research: A hypothesis, regardless of its source, states what a researcher is looking for. It also suggests some plausible explanations about the probable relationships between the concepts or variables indicated therein. In fact, it navigates the research. Without it, no further step is possible in empirical research or non-doctrinal legal research. A hypothesis helps the researcher in drawing 'meaningful conclusions' supported by 'relevant' empirical data. A hypothesis serves as a sound guide to: (i) the kind of data that must be collected in order to answer the research problem; (ii) the way in which the data should be organized most efficiently and meaningfully, and (iii) the type of methods that can be used for making analysis of the data.

Role of 'tested' hypothesis: A hypothesis needs to be empirically tested to draw some inferences about the initially posited relationship between the variables indicated in the hypothesis. Therefore, when it is empirically tested (or not), the initially assumed relationship between the concepts or variables, as the case may be, becomes a proved fact. Once a hypothesis is established, it ceases to be a hypothesis.

A hypothesis also performs the following significant functions:

1. Test theories: A hypothesis, when empirically proved, helps us in testing an existing theory. A theory is not a mere speculation, but it is built upon facts. It is a set of inter-related propositions or statements organized into a deductive system that offers an explanation of some phenomenon. Facts constitute a theory when they are assembled, ordered and seen in a relationship. Therefore, when a hypothesis is 'tested', it not only supports the existing theory that accounts for description of some social phenomenon but also in a way 'tests' it.
2. Suggest new theories: A hypothesis, even though related to some existing theory, may, after tested, reveal certain 'facts' that are not related to the existing theory or disclose relationships other than those stated in the theory. It does not support the existing theory but suggests a new theory.
3. Describe social phenomenon: A hypothesis also performs a descriptive function. Each time a hypothesis is tested empirically, it tells us something about the phenomenon it is associated with. If the hypothesis is empirically supported, then our information about the phenomenon increases. Even if the hypothesis is refuted, the test tells us something about the phenomenon we did not know before.
4. Suggest social policy: A hypothesis, after its testing, may highlight such 'ills' of the existing social or legislative policy. In such a situation, the tested hypothesis helps us in formulating (or reformulating) a social policy. It may also suggest or hint at probable solutions to the existing social problem(s) and their implementation.
5. Suggest social policy: A hypothesis, after its testing, may highlight such 'ills' of the existing social or legislative policy. In such a situation, the tested hypothesis helps us in formulating (or reformulating) a social policy. It may also suggest or hint at probable solutions to the existing social problem(s) and their implementation. [5-7]

10.6 Importance of Hypothesis:

- Hypothesis as the Investigator's 'Eyes': By guiding the investigator in further investigation it serves as the investigator's 'Eyes' in seeking answers to tentatively adopted generalization.
- It Focuses Research: Without it, research is unfocussed research and remains like a random empirical wandering. It serves as necessary link between theory and the investigation.
- It Places Clear and Specific Goals: A well thought out set of hypothesis is that they place clear and specific goals before the research worker and provide researcher with a basis for selecting sample and research procedure to meet these goals.
- It Links Together: It serves the important function of linking together related facts and information and organizing them into wholes.
- It Prevents Blind Research: The use of hypothesis prevents a blind search and indiscriminate gathering of masses of data which may later prove irrelevant to the problem under study.
- As a Sort of Guiding Light: A hypothesis serves as a powerful beacon that lights the way for the research work.

10.7 Characteristics of a Good Hypothesis:

A good hypothesis must possess the following characteristics [8]

- Is never formulated in the form of a question.
- Should be empirically testable, whether it is right or wrong.
- Should be specific and precise.
- Should not be contradictory.
- Should specify variables between which the relationship is to be established.
- Should describe one issue only. A hypothesis can be formed either in descriptive or relational form.
- Soes not conflict with any law of nature which is known to be true.
- Guarantees that available tools and techniques will be effectively used for the purpose of verification.
- Should be stated as far as possible in most simple terms so that the same is easily understandable by all concerned.
- Must explain the facts that gave rise to the need for explanation.
- Should be amenable to testing within a reasonable time.

10.8 Types of Research Hypothesis:

Before researchers can begin working on a question that interests them, they need to formulate a research hypothesis. This is an important step in the scientific method because this determines the direction of the study. Scientists need to scrutinize previous work in the area and select an experimental design to use that helps them find data that either supports or rejects their hypothesis. [9-11] Research hypotheses are of different types: simple, complex, directional, no directional, associative, causal, inductive & deductive, null, and alternative or research.

A. Simple Hypothesis: This predicts the relationship between a single independent variable (IV) and a single dependent variable (DV). For example: Lower levels of exercise postpartum (IV) will be associated with greater weight retention (DV).

B. Complex Hypothesis: This predicts the relationship between two or more independent variables and two or more dependent variables. Example of a complex multiple independent variable hypothesis - low risk pregnant women (IV) who

- value health highly;
- believe that engaging in health promoting behaviours will result in positive outcomes;
- perceive fewer barriers to health promoting activities;

Are more likely than other women to attend pregnancy-related education programs (DV). Another example of a complex multiple dependent variable hypothesis - the implementation of an evidence based protocol for urinary incontinence (IV) will result in (DV)

- decreased frequency of urinary incontinence episodes;
- decreased urine loss per episode;
- Decreased avoidance of activities among women in ambulatory care settings.

C. Directional Hypothesis: This may imply that the researcher is intellectually committed to a particular outcome. They specify the expected direction of the relationship between variables i.e. the researcher predicts not only the existence of a relationship but also its nature. Scientific journal articles generally use this form of hypothesis. The investigator bases this hypothesis on the trends apparent from previous research on this topic. Considering the example, a researcher may state the hypothesis as, 'High school students who participate in extracurricular activities have a lower GPA than those who do not participate in such activities.' Such hypotheses provide a definite direction to the prediction.

D. No directional Hypothesis: This form of hypothesis is used in studies where there is no sufficient past research on which to base a prediction. Do not stipulate the direction of the relationship. Continuing with the same example, a no directional hypothesis would read, 'The academic performance of high school students is related to their participation in extracurricular activities.'

E. Associative Hypothesis: Associative hypotheses propose relationships between variables, when one variable changes, the other changes. Do not indicate cause and effect.

F. Causal Hypothesis: Causal hypotheses propose a cause and effect interaction between two or more variables. The independent variable is manipulated to cause effect on the dependent variable. The dependent variable is measured to examine the effect created by the independent variable. For the example mentioned, the causal hypothesis will state,

'High school students who participate in extracurricular activities spend less time studying which leads to a low GPA.' When verifying such hypotheses, the researcher needs to use statistical techniques to demonstrate the presence of a relationship between the cause and effect. Such hypotheses also need the researcher to rule out the possibility that the effect is a result of a cause other than what the study has examined.

G. Inductive and Deductive Hypotheses: Inductive hypotheses are formed through inductively reasoning from many specific observations to tentative explanations. Deductive hypotheses are formed through deductively reasoning implications of theory.

I. Null Hypothesis: This is a hypothesis that proposes no relationship or difference between two variables. This is the conventional approach to making a prediction. It involves a statement that says there is no relationship between two groups that the researcher compares on a certain variable. The hypothesis may also state that there is no significant difference when different groups are compared with respect to a particular variable. For example, 'There is no difference in the academic performance of high school students who participate in extracurricular activities and those who do not participate in such activities' is a null hypothesis. It asserts that there is no true difference in the sample statistic and population parameter under consideration (hence the word 'null' which means invalid, void, or a mounting to nothing) and that the difference found is accidental arising out of fluctuations of sampling. It is denoted as H0.

Table 10.1 States of Nature and Decisions on Null Hypothesis

Decision on Null Hypothesis	States of Nature	
	Null Hypothesis True	**Null Hypothesis False**
Accept	Correct Decision Probability = 1-α	Type II error Probability =β
Reject	Type I error Probability = α (α is called significance level)	Correct Decision Probability =1-β (1-β is called power of a test)

The rejection of the null hypothesis indicates that the differences have statistical significance and the acceptance of the null hypothesis indicates that the differences are due to chance.

J. Alternate or Research Hypothesis:

This hypothesis proposes a relationship between two or more variables, symbolized as H1. For example, if a researcher was interested in examining the relationship between music and emotion, s/he may believe that there is a relationship between music and emotion. H_1 (the research/alternate hypothesis): Music at a fast tempo is rated by participants as being happier than music at a slow tempo. H_0 (the null hypothesis): Music at a fast tempo and at a slow tempo is rated the same in happiness by participants. The two hypotheses we propose to test must be mutually exclusive; i.e., when one is true the other must be false. And we see that they must be exhaustive; they must include all possible occurrences.

K. Statistical Hypothesis:

Statistical hypothesis is an assumption about statistical populations that one seeks to support or refute. The null hypothesis and alternative hypothesis together are called statistical hypothesis.

10.9 Testing the Hypothesis:

10.9.1 Approaches of Hypothesis Testing:

There are three approaches of hypothesis testing (Table 10.2). Each approach requires different subjective criteria and objective statistics but ends up with the same conclusion [12-15]

10.9.2 Test Statistic Approach:

The classical test statistic approach computes a test statistic from empirical data and then compares it with a critical value. If the test statistic is larger than the critical value or if the test statistic falls into the rejection region, the null hypothesis is rejected.

10.9.3 P-Value Approach:

In the p-value approach, researchers compute the p-value on the basis of a test statistic and then compare it with the significance level (test size). If the p-value is smaller than the significance level, researches reject the null hypothesis. A p-value is considered as amount of risk that researchers have to take when rejecting the null hypothesis.

10.9.4 Confidence Interval Approach:

Finally, the confidence interval approach constructs the confidence interval and examines if a hypothesized value falls into the interval.

The null hypothesis is rejected if the hypothesized value does not exist within the confidence interval.

Table 10.2 Three Approaches of Hypothesis Testing

	Test Statistic Approach	**ρ -Value Approach**	**Confidence Interval Approach**
1	State H_0 and H_1	State H_0 and H_1	State H_0 and H_1
2	Determine test size α and find the critical value	Determine test size α	Determine test size α or 1- α and a hypothesized value
3	Compute a test statistic	Compute a test statistic and its ρ-value	Construct the (1- α)100% confidence interval
4	Reject H_0 if Test Statistic > Critical Value	Reject H_0 if ρ –Value < α	Reject H_0 if a hypothesized value does not exist in Confidence Interval
5	Substantive interpretation	Substantive interpretation	Substantive interpretation

10.9.5 Procedure for/ Steps of Hypothesis Testing:

All hypothesis tests are conducted the same way. The researcher states a hypothesis to be tested, formulates an analysis plan, analyses sample data according to the plan, and accepts or rejects the null hypothesis, based on results of the analysis. [16-18]

10.9.6 Limitation of the Tests of Hypothesis:

We have some important tests (both parametric and non-parametric) often used for testing hypotheses on the basis of which important decisions may be based.

But there are several limitations of the said tests which should always be borne in mind by a researcher. [19, 20] Important limitations are as follows-

- The tests should not be used in a mechanical fashion. It should be kept in view that testing is not decision-making itself; the tests are only useful aids for decision-making. Hence, proper interpretation of statistical evidence is important to intelligent decisions.
- Test do not explain the reasons as to why do the difference exist, say between the means of the two samples. They simply indicate whether the difference is due to fluctuations of sampling or because of other reasons but the tests do not tell us as to which is/are the other reason(s) causing the difference.
- Results of significance tests are based on probabilities and as such cannot be expressed with full certainty. When a test shows that a difference is statistically significant, then it simply suggests that the difference is probably not due to chance.
- Statistical inferences based on the significance tests cannot be said to be entirely correct evidences concerning the truth of the hypotheses. This is specially so in case of small samples where the probability of drawing erring inferences happens to be generally higher. For greater reliability, the size of samples be sufficiently enlarged.

All these limitations suggest that in problems of statistical significance, the inference techniques (or the tests) must be combined with adequate knowledge of the subject-matter along with the ability of good judgement.

10.10 Conclusion:

Hypothesis testing is an important activity of evidence-based research. A well worked up hypothesis is half the answer to the research question. For this, both knowledge of the subject derived from extensive review of the literature and working knowledge of basic statistical concepts are desirable.

This paper discusses the methods of working up a good hypothesis and statistical concepts of hypothesis testing. Where Var Hypothesis testing is one of the most widely used, and some may say abused, methodologies in statistics.

Formally, the hypotheses are specified, a α-level is chosen, a test statistic is calculated, and it is reported whether H_0 or H_1 is accepted. In practice, it may happen that hypotheses are suggested by the data, the choice of α -level may be ignored, more than one test statistic is calculated, and many modifications to the formal procedure may be made.

Most of these medications cause bias and can invalidate the method. For example, a hypothesis suggested by the data is likely to be one that has `stood out' for some reason, and hence $H_1$is likely to be accepted unless the bias is corrected for (using something like Scheffe's method–see Hsu 1996). [21]

10.11 References:

1. Ader, H.J., Mellenbergh, G.J., & Hand, D.J. (2008). advising on Research Methods: A Consultant's Companion. Huizen, The Netherlands: Johannes vankessel Publishing.
2. Alam, S.S. & Kabir, S.M.S. (2015). Classroom Management in Secondary Level: Bangladesh Context. International Journal of Scientific and Research Publications, www.ijsrp.org.
3. Alam, S.S., Kabir, S.M.S., & Aktar, R. (2015). General Observation, Cognition, Emotion, Social, Communication, Sensory Deficiency of Autistic Children. Indian Journal of Health and Wellbeing.
4. Dana P. Turner, Hao Deng and Timothy T. Houle; Statistical Hypothesis Testing: Overview and Application; https://doi.org/10.1111/head.13706
5. Daniel W. W. In: Biostatistics. 7th ed. New York: John Wiley and Sons, Inc; 2002. Hypothesis testing; pp. 204–294.
6. Gigerenzer, G. The Superego, the Ego, and the id in Statistical Reasoning. In A Handbook for Data Analysis in the Behavioral Sciences: Methodological Issues; Lawrence Erlbaum Associates, Inc.: Mahwah, NJ, USA, 1993;pp. 311–339
7. Hulley S. B, Cummings S. R, Browner W. S, Grady D, Hearst N, and Newman T. B. 2nd ed. Philadelphia: Lippincott Williams and Wilkins; 2001. Getting ready to estimate sample size: Hypothesis and underlying principles In: Designing Clinical Research-An epidemiologic approach; pp. 51–63.
8. Kabir, S.M.S. (2018). Psychological health challenges of the hill-tracts region for climate change in Bangladesh. Asian Journal of Psychiatry, Elsevier.
9. Kabir, S.M.S., Aziz, M.A., & Jahan, A.K.M.S. (2018). Women Empowerment and Governance in Bangladesh. ANTYAJAA: Indian journal of Women and Social Change, SAGE Publications India Pvt. Ltd.
10. Kabir, S.M.S. (2013). Positive Attitude Can Change Life. Journal of Chittagong University Teachers' Association.
11. Kabir, S.M.S. & Mahtab, N. (2013). Gender, Poverty and Governance Nexus: Challenges and Strategies in Bangladesh.
12. Medawar P. B. Philadelphia: American Philosophical Society; 1969. Induction and intuition in scientific thought. Popper K. Unended Quest. An Intellectual Autobiography. Fontana Collins; p. 42.
13. Sendil Mourougan, Dr. K. Sethuraman; Hypothesis Development and Testing; IOSR Journal of Business and Management (IOSR-JBM) e-ISSN: 2278-487X, p-ISSN: 2319-7668. Volume 19, Issue 5. Ver. I (May. 2017), PP 34-40www.iosrjournals.org
14. Wobeser G.A. (1994) Formulating and Testing Hypotheses. In: Investigation and Management of Disease in Wild Animals. Springer, Boston, MA. https://doi.org/10.1007/978-1-4757-5609-8_6
15. Wulff H. R, Pedersen S. A, Rosenberg R. Oxford: Blackwell Scientific Publicatons; Empirism and Realism: A philosophical problem. In: Philosophy of Medicine
16. R. Johnson and G. Bhattacharyya, Statistics: Principles and Methods; 3rd edition; John Wiley and Sons, Inc.; 1996.
17. Blalock, HM (1960), Social Statistics, NY: McGraw-Hill.

18. Goode, WJ & Hatt, PK (1981). Methods in Social Research. Tokyo: McGrawhill Book Company.
19. Lehmann E L 1986Testing Statistical Hypotheses, 2nd edn. Springer, New York
20. Berger R L 1982 Multipara meter hypothesis testing and ac-acceptance sampling. Technometrics24: 295±300
21. Hsu J C 1996Multiple Comparisons, Theory and Methods. Chapman & Hall, London

ISBN: 978-93-90847-07-5

Chapter - 11 : An Overview of Multivariate Analysis

Chandra Prakash Saini

Assistant Professor of Chemistry, G. H. S. Govt. P. G. College,
H. Sujangarh, Churu.

Abstract:

Multivariate means involving multiple dependent variables resulting in one outcome. This explains that the majority of the problems in the real world are Multivariate. For example, we cannot predict the weather of any year based on the season. There are multiple factors like pollution, humidity, precipitation, etc. Here, we will introduce you to multivariate analysis, its history, and its application in different fields.

Multivariate analysis is used widely in many industries, like healthcare. In the recent event of COVID-19, a team of data scientists predicted that Delhi would have more than 5lakh COVID-19 patients by the end of July 2020. This analysis was based on multiple variables like government decision, public behaviour, population, occupation, public transport, healthcare services, and overall immunity of the community.

Keywords: Multivariate, Analysis, Multivariate Analysis,

11.1 Introduction:

11.2 The History of Multivariate Analysis:

In 1928, Wishart presented his paper. The Precise distribution of the sample covariance matrix of the multivariate normal population, which is the initiation of MVA. In the 1930s, R.A. Fischer, Hotelling, S.N. Roy, and B.L. Xu et al. made a lot of fundamental theoretical work on multivariate analysis. At that time, it was widely used in the fields of psychology, education, and biology. In the middle of the 1950s, with the appearance and expansion of computers, multivariate analysis began to play a big role in geological, meteorological.

Medical and social and science. From then on, new theories and new methods were proposed and tested constantly by practice and at the same time, more application fields were exploited. With the aids of modern computers, we can apply the methodology of multivariate analysis to do rather complex statistical analyses.

11.2.1 Definition:

Multivariate analysis in a broad sense is the set of statistical methods aimed simultaneously analyse datasets. That is, for each individual or object being studied, analysed several variables. The essence of multivariate thinking is to expose the inherent structure and meaning revealed within these sets if variables through application and interpretation of various statistical methods. Suppose a project has been assigned to you to predict the sales of the company. You cannot simply say that 'X' is the factor which will affect the sales.

There are two determining factors that have to take into account when doing a multivariate approach [1]: (I) the multidimensional nature of the data matrix and (II) the purpose of trying it, preserving its complex structure. This is based on the belief that the variables are interrelated, so that only the set of the same test may provide a better understanding of the studied object obtaining information univariate and bivariate statistical methods are unable to achieve. The joint treatment of the variables will faithfully reflect the reality of the problem addressed [2].

11.2.2 Types of Multivariate Methods: Multivariate methods can be classified based on the types of variables [3] (Figure 11.1):

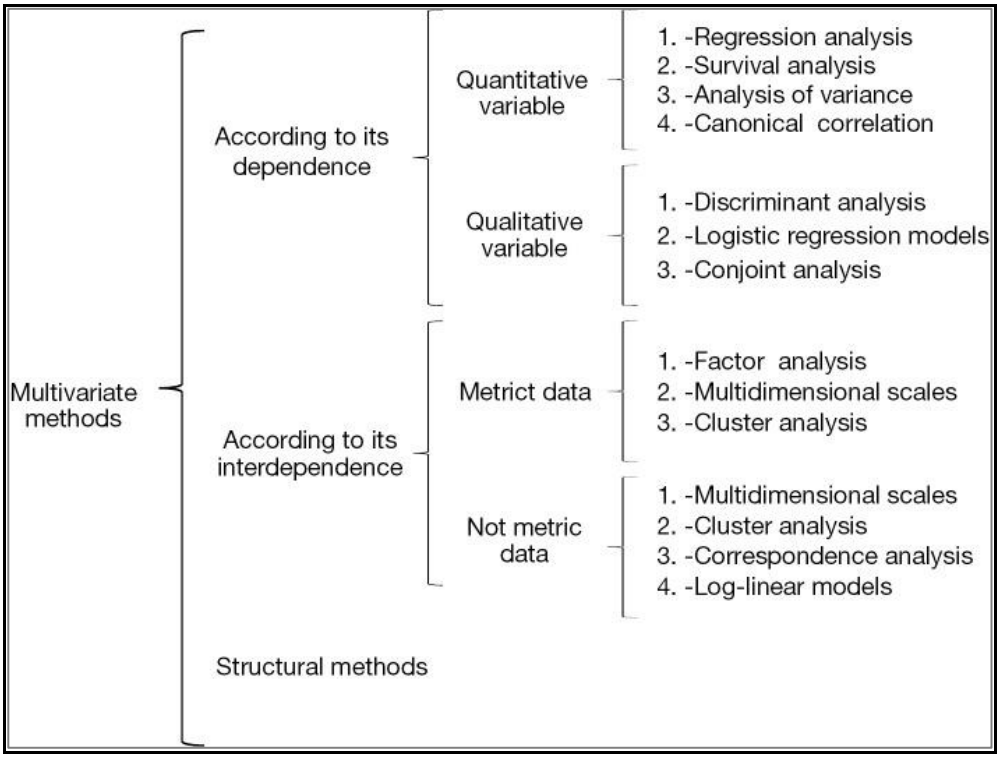


Figure 11.1: Classification of Multivariate Methods.

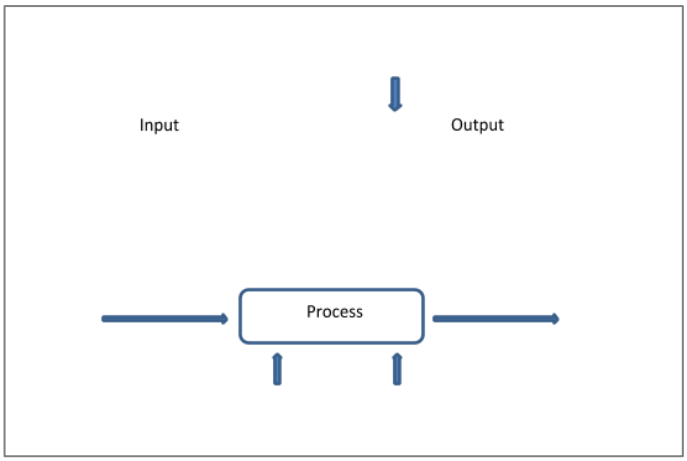
We know that there are multiple aspects or variables which will impact sales. To analyse the variables that will impact sales majorly, can only be found with multivariate analysis. And in most cases, it will not be just one variable.

Like we know, sales will depend on the category of product, production capacity, geographical location, marketing effort, presence of the brand in the market, competitor analysis, cost of the product, and multiple other variables. Sales is just one example; this study can be implemented in any section of most of the fields.

As per the Data Analysis study by Murtaza Haider of Ryerson University on the coast of the apartment and what leads to an increase in cost or decrease in cost, is also based on multivariate analysis. As per that study, one of the major factors was transport infrastructure.

People were thinking of buying a home at a location which provides better transport, and as per the analysing team, this is one of the least thought of variables at the start of the study. But with analysis, this came in few final variables impacting outcome. Multivariate analysis is part of exploratory data analysis. Based on MVA, we can visualize the deeper insight of multiple variables. There are more than 20 different methods to perform multivariate analysis and which method is best depends on the type of data and the problem you are trying to solve. [4]

Multivariate Analysis (**MVA**) is a Statistical procedure for analysis of data involving more than one type of measurement or observation. It may also mean solving problems where more than one dependent variable is analysed simultaneously with other variables.



There are three categories of analysis to be aware of:

- **Univariate analysis**, which looks at just one variable
- **Bivariate analysis**, which analyses two variables
- **Multivariate analysis**, which looks at more than two variables

As you can see, multivariate analysis encompasses all statistical techniques that are used to analyse more than two variables at once. The aim is to find patterns and correlations between several variables simultaneously—allowing for a much deeper, more complex understanding of a given scenario than you'll get with bivariate analysis. [5]

There are several steps to teaching how to write about multivariate analysis in graduate coursework or for dissertation writers. First, assign readings that cover key principles about statistical research writing, such as Miller (2005), Treiman (2009), or other books or articles on writing or professional research practice. Second, in lecture, briefly cover the principles and associated skills for writing about multivariate analysis, followed by in-class demonstration using such as the "poor/better/best" technique (shown below) to show students examples of how to translate abstract writing principles into concrete sentences or paragraphs; see Miller (2005) or Miller, England, Treiman and Wu (2009). Third, reinforce those concepts by assigning students to apply them to their own work or to evaluating existing published work, using one of several types of exercises, such as those shown below. Fourth, have the students use checklists such as those at the end of each chapter in The Chicago Guide to Writing about Multivariate Analysis (Miller, 2005) to plan and evaluate their work. [6-8].

11.2.3 Multivariate Analysis Example:

Wells et al.[9] published in New England Journal of Medicine a study were they hypothesized that a computed tomographic (CT) metric of pulmonary vascular disease [pulmonary artery enlargement, as determined by a ratio of the diameter of the pulmonary artery to the diameter of the aorta (PA: A ratio) of >1] would be associated with previous severe COPD exacerbations . A univariate logistic regression was used to determine the associations between patient characteristics (including the PA: A ratio) and the occurrence of a severe exacerbation of COPD in the year before enrollment. Variables showing a univariate association with severe exacerbations (at $P<0.10$) were included in stepwise backward multivariate logistic models to adjust for confounders.

These models included also variables previously reported to be independently associated with acute exacerbations of COPD in the ECLIPSE study as gastro-esophageal reflux disease (GERD), lower values for the forced expiratory volume in 1 second (FEV1), a history of acute exacerbations of COPD within the previous year, increased white-cell count, and decreased quality of life as measured by the St. George's Respiratory Questionnaire (SGRQ) score (which ranges from 0 to 100, with higher scores indicating worse quality of life and with a minimal clinically important difference of 4 points). Authors found significant univariate associations between severe exacerbations and younger age, black race, use of supplemental oxygen, congestive heart failure, sleep apnea, thromboembolic disease, GERD, asthma, chronic bronchitis, employment in a hazardous job. Thanks to the development of a multivariate model, it will not only let to handle many covariates, it will let to asses potential confounders and also test for interaction or effect modification. Multiple logistic-regression analyses showed continued significant independent associations between severe exacerbations and younger age, lower FEV1 values, higher score on the SGRQ, and a PA: A ratio of more than 1.

11.2.4 Variables in Multivariate Analysis Research Methodology

Before we describe the various multivariate techniques, it seems appropriate to have a clear idea about the term, 'variables' used in the context of multivariate analysis. Many variables used in multivariate analysis can be classified into different categories from several points of view. Important ones are as under: [10]

a. Explanatory variable and criterion variable: If X may be considered to be the cause of Y, then X is described as explanatory variable (also termed as causal or independent variable) and Y is described as criterion variable (also termed as resultant or dependent variable). In some cases both explanatory variable and criterion variable may consist of a set of many variables in which case set (X1, X2, X3, …., Xp) may be called a set of explanatory variables and the set (Y1, Y2, Y3, …., Yq) may be called a set of criterion variables if the variation of the former may be supposed to cause the variation of the latter as a whole. In economics, the explanatory variables are called external or exogenous variables and the criterion variables are called endogenous variables. Some people use the term external criterion for explanatory variable and the term internal criterion for criterion variable.
b. Observable variables and latent variables: Explanatory variables described above are supposed to be observable directly in some situations, and if this is so, the same are termed as observable variables. However, there are some unobservable variables which may influence the criterion variables. We call such unobservable variables as latent variables.

c. Discrete variable and continuous variable: Discrete variable is that variable which when measured may take only the integer value whereas continuous variable is one which, when measured, can assume any real value (even in decimal points).
d. Dummy variable (or Pseudo variable): This term is being used in a technical sense and is useful in algebraic manipulations in context of multivariate analysis. We call Xi (i = 1, …., m) a dummy variable, if only one of Xi is 1 and the others are all zero.

11.2.5 Characteristics of Multivariate Analysis Techniques:

Multivariate analysis techniques are largely empirical and deal with the reality; they possess the ability to analyse complex data. Accordingly in most of the applied and behavioural researches, we generally resort to multivariate analysis techniques for realistic results. Besides being a tool for analysing the data, multivariate techniques also help in various types of decision-making. For example, take the case of college entrance examination wherein a number of tests are administered to candidates, and the candidates scoring high total marks based on many subjects are admitted.

This system, though apparently fair, may at times be biased in favour of some subjects with the larger standard deviations. Multivariate techniques may be appropriately used in such situations for developing norms as to who should be admitted in college. We may also cite an example from medical field. Many medical examinations such as blood pressure and cholesterol tests are administered to patients.

Each of the results of such examinations has significance of its own, but it is also important to consider relationships between different test results or results of the same tests at different occasions in order to draw proper diagnostic conclusions and to determine an appropriate therapy. Multivariate techniques can assist us in such a situation. In view of all this, we can state that "if the researcher is interested in making probability statements on the basis of sampled multiple measurements, then the best strategy of data analysis is to use some suitable multivariate statistical technique."

The basic objective underlying multivariate techniques is to represent a collection of massive data in a simplified way. In other words, multivariate techniques transform a mass of observations into a smaller number of composite scores in such a way that they may reflect as much information as possible contained in the raw data obtained concerning a research study.

Thus, the main contribution of these techniques is in arranging a large amount of complex information involved in the real data into a simplified visible form. Mathematically, multivariate techniques consist in "forming a linear composite vector in a vector subspace, which can be represented in terms of projection of a vector onto certain specified subspaces." For better appreciation and understanding of multivariate techniques, one must be familiar with fundamental concepts of linear algebra, vector spaces, orthogonal and oblique projections and univariate analysis.

Even then before applying multivariate techniques for meaningful results, one must consider the nature and structure of the data and the real aim of the analysis. We should also not forget that multivariate techniques do involve several complex mathematical computations and as such can be utilized largely with the availability of computer facility. [11]

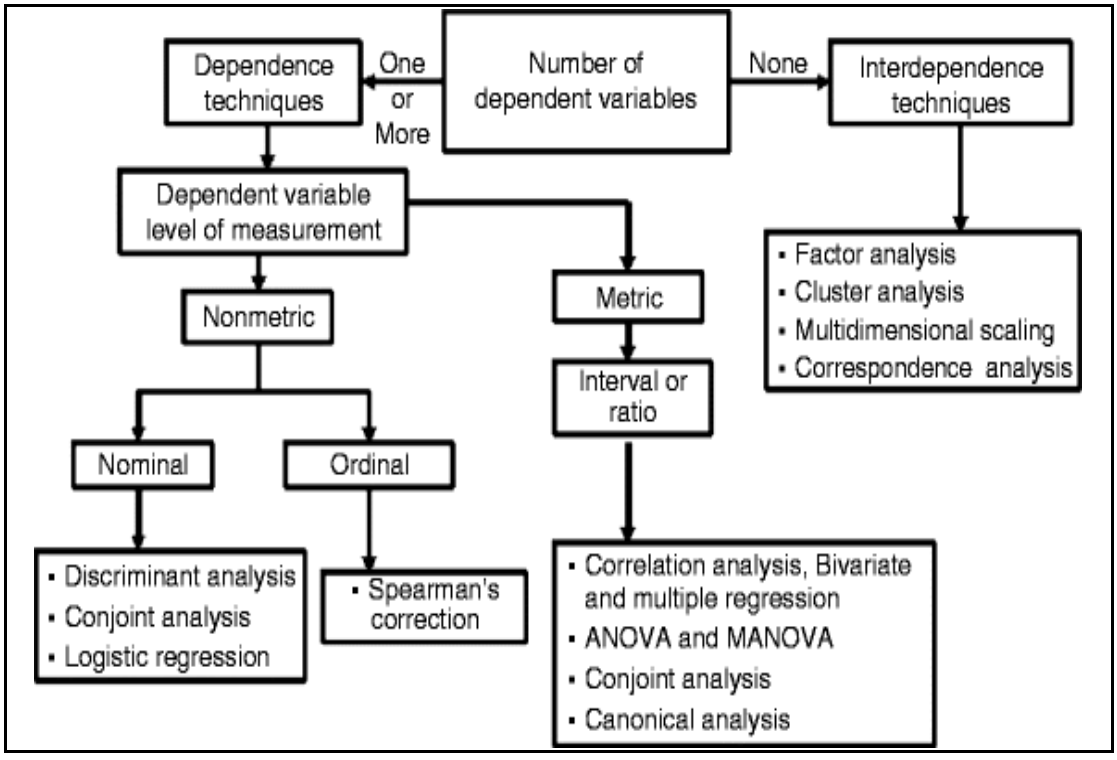
11.2.6 Stages of Realization of a Multivariate Analysis:

The steps (I) to perform a multivariate analyse can be summarized in:

I. State the objectives of the analysis. Define problem in its conceptual terms, objectives and multivariate techniques that are going to be employed.
II. Design analysis. To determine the sample size and estimation techniques those are going to be employed.
III. Decide what to do with the missing data.
IV. Perform the analysis. Identify outliers and influential observations whose influence on the estimates and goodness of fit should be analysed.
V. Interpret the results. These interpretations can lead to redefine the variables or the model which can return back to steps (III) and (IV).
VI. Validate the results. At this point, we must establish the validity of the results obtained by analysing other results obtained with the sample is generalized to the population from which it comes.

11.2.7 Classification Chart of Multivariate Techniques:

Selection of the appropriate multivariate technique depends upon-



a. Are the variables divided into independent and dependent classification?
b. If yes, how many variables are treated as dependents in a single analysis?
c. How are the variables, both dependent and independent measured?

Multivariate analysis technique can be classified into two broad categories viz., [12] this classification depends upon the question: are the involved variables dependent on each other or not?

11.2.8 The Objective of Multivariate Analysis:

1. **Data reduction or structural simplification**: This helps data to get simplified as possible without sacrificing valuable information. This will make interpretation easier.
2. **Sorting and grouping**: When we have multiple variables, Groups of "similar" objects or variables are created, based upon measured characteristics.
3. **Investigation of dependence among variables**: The nature of the relationships among variables is of interest. Are all the variables mutually independent or are one or more variables dependent on the others?
4. **Prediction Relationships between variables**: must be determined for the purpose of predicting the values of one or more variables based on observations on the other variables.
5. **Hypothesis construction and testing**. Specific statistical hypotheses, formulated in terms of the parameters of multivariate populations, are tested. This may be done to validate assumptions or to reinforce prior convictions.

11.3 Important Methods of Factor Analysis – Research Methodology:

There are several methods of factor analysis, but they do not necessarily give same results. As such factor analysis is not a single unique method but a set of techniques. Important methods of factor analysis are:

1. The centroid method;
2. The principal components method;
3. The maximum likelihood method.

Before we describe these different methods of factor analysis, it seems appropriate that some basic terms relating to factor analysis be well understood. [13, 14]

A. Factor: A factor is an underlying dimension that account for several observed variables. There can be one or more factors, depending upon the nature of the study and the number of variables involved in it.

B. Factor-Loadings: Factor-loadings are those values which explain how closely the variables are related to each one of the factors discovered. They are also known as factor-variable correlations. In fact, factor-loadings work as key to understanding what the factors mean. It is the absolute size (rather than the signs, plus or minus) of the loadings that is important in the interpretation of a factor.

C. Communality (h2): Communality, symbolized as h2, shows how much of each variable is accounted for by the underlying factor taken together. A high value of communality means that not much of the variable is left over after whatever the factors represent is taken into consideration. It is worked out in respect of each variable as under: h2 of the ith variable = (ith factor loading of factor A) 2 + (ith factor loading of factor B) 2 + …

D. Eigen Value (or Latent Root): When we take the sum of squared values of factor loadings relating to a factor, then such sum is referred to as Eigen Value or latent root.

Eigen value indicates the relative importance of each factor in accounting for the particular set of variables being analysed.

E. Total Sum of Squares: When Eigen values of all factors are totalled, the resulting value is termed as the total sum of squares. This value, when divided by the number of variables (involved in a study), results in an index that shows how the particular solution accounts for what all the variables taken together represent. If the variables are all very different from each other, this index will be low. If they fall into one or more highly redundant groups, and if the extracted factors account for all the groups, the index will then approach unity.

F. Rotation: Rotation, in the context of factor analysis, is something like staining a microscope slide. Just as different stains on it reveal different structures in the tissue, different rotations reveal different structures in the data. Though different rotations give results that appear to be entirely different, but from a statistical point of view, all results are taken as equal, none superior or inferior to others.

However, from the standpoint of making sense of the results of factor analysis, one must select the right rotation. If the factors are independent orthogonal rotation is done and if the factors are correlated, an oblique rotation is made. Communality for each variables will remain undisturbed regardless of rotation but the Eigen values will change as result of rotation.

G. Factor Scores: Factor score represents the degree to which each respondent gets high scores on the group of items that load high on each factor. Factor scores can help explain what the factors mean. With such scores, several other multivariate analyses can be performed. We can now take up the important methods of factor analysis.

11.4 Advantages and Disadvantages of Multivariate Analysis:

A. Advantages:

The main advantage of multivariate analysis is that since it considers more than one factor of independent variables that influence the variability of dependent variables, the conclusion drawn is more accurate. The conclusions are more realistic and nearer to the real-life situation.

B. Disadvantages:

The main disadvantage of MVA includes that it requires rather complex computations to arrive at a satisfactory conclusion. Many observations for a large number of variables need to be collected and tabulated; it is a rather time-consuming process.

Key Takeaways and Further Reading

In this post, we've learned that multivariate analysis is used to analyse data containing more than two variables. To recap, here are some key takeaways:

The aim of multivariate analysis is to find patterns and correlations between several variables simultaneously Multivariate analysis is especially useful for analysing complex datasets, allowing you to gain a deeper understanding of your data and how it relates to real-world scenarios.

There are two types of multivariate analysis techniques: Dependence techniques, which look at cause-and-effect relationships between variables, and interdependence techniques, which explore the structure of a dataset.

Key multivariate analysis techniques include multiple linear regression, multiple logistic regression, MANOVA, factor analysis, and cluster analysis—to name just a few.

11.5 Limitations of Multivariate Analysis:

Multivariate techniques are complex and involve high level mathematics that require a statistical program to analyse the data. These statistical programs can be expensive for an individual to obtain. One of the biggest limitations of multivariate analysis is that statistical modeling outputs are not always easy for students to interpret. For multivariate techniques to give meaningful results, they need a large sample of data; otherwise, the results are meaningless due to high standard errors. Standard errors determine how confident you can be in the results, and you can be more confident in the results from a large sample than a small one. Running statistical programs is fairly straightforward but does require statistical training to make sense of the data. [15]

11.6 Significance for Usability:

As a quantitative method, multivariate analysis is one of the most effective methods of testing usability. At the same time, it is very complex and sometimes cost-intensive. Software can be used to help, but the tests as such are considerably more complex than A/B tests in terms of study design. The decisive advantage lies in the number of variables that can be considered and their weighting as a measure of the significance of certain variables.

Even four different versions of an article's headline can result in completely different click rates. The same applies to the design of buttons or the background colour of the order form. In individual cases, it is therefore worth considering from a multivariate perspective also financially, especially for commercially oriented websites, such as online shops or websites, which are to be amortized through advertising.[16]

11.7 Application of Multivariate Analysis:

- For developing taxonomies or systems of classification
- To investigate useful
- ways to conceptualize or group items
- To generate hypotheses
- To test hypotheses

Finds application in biology, medicine, psychology, neuroscience, market research, educational research, climatology, petroleum geology, crime analysis etc.

11.8 Conclusion:

This Chapter provides a brief overview of the importance of using multivariate studies in the health sciences and the different types of existing methods and their application depending on the type of variables to deal with. In addition, it described the steps to follow to design a multivariate study.

11.9 References:

1. Gil Pascual JA. Methods worth of research in education. Multivariate Analysis 2003.
2. Grimm LG, Yarnold PR. Eds. Reading and understanding multivariate statistics. Washington, DC: American Psychological Association Washington, 2011.
3. Rencher AC, Christensen WF. Eds. Methods of Multivariate Analysis. New Jersey: Wiley, 2012.
4. Berg, B.L. (2012). *Research Methods Qualitative for the Social Science*. (8th Ed). Long Beach: Allyn and Bacon.
5. Cohen, L et al (2007) *Research Methods in Education*. London. Routledge.
6. Miller, Jane E.2005. The Chicago Guide to Writing about Multivariate Analysis. The Chicago Guides to Writing, Editing and Publishing. University of Chicago Press.
7. Miller, Jane E., Paula England, Donald J. Treiman, and Lawrence Wu. "Learning How to Write about Multivariate Analysis for Sociologists: Integrating Concepts from Statistics, Research Methods, and Writing Courses." Working paper, 2009.
8. Treiman, Donald J. 2009. Quantitative Data Analysis: Doing Social Research to Test Ideas. San Francisco: Jossey-Bass.
9. Wells JM, Washko GR, Han MK, et al. Pulmonary arterial enlargement and acute exacerbations of COPD. N Engl J Med 2012; 367:913-21.
10. Creswell J.W. (1998) *Qualitative Inquiry and research design*. Thousand Oaks. Sage Publications.
11. Parahoo. K. (2006). Nursing Research - Principles, Process and Issues. (2r.sedn).Hounds mill: Palgrave.
12. Patrick, Li & Munro. S. (2004). The literature review: demystifying the literature search. Diabetes Educ. 30(1):30-8.
13. Polit, D.F, & Beck, C.T. (2006). Essentials of Nursing Research: Methods, Appraisal and Utilization. (C'edn.). Philadelphia: Lippincott, Williams & Wilkins.
14. Sharma, Y.K. (2011). Elements of Educational Research. New Delhi: Kanishka Publishers.
15. Alvin C. Rencher.2002: "Methods of Multivariate Analysis ", A. John Wiley & sons, inc. publication, Second Edition.
16. Ding Shi-Sheng 1981: "Multiple analysis method and its applications", Jilin People's Publishing House, Changchun.

ISBN: 978-93-90847-07-5

Chapter - 12 : A Study on Scientific Process and Research

Dr. Vinod Mandal

Associate Professor, Dept. of Chemistry, A. N. College Patna,
Patliputra University.

Abstract:

Scientific investigations are experiments which should be prepared before they are carried out systematically. This analysis explains classification and explanation of experimental experiments, randomization and bias in the planning stage.

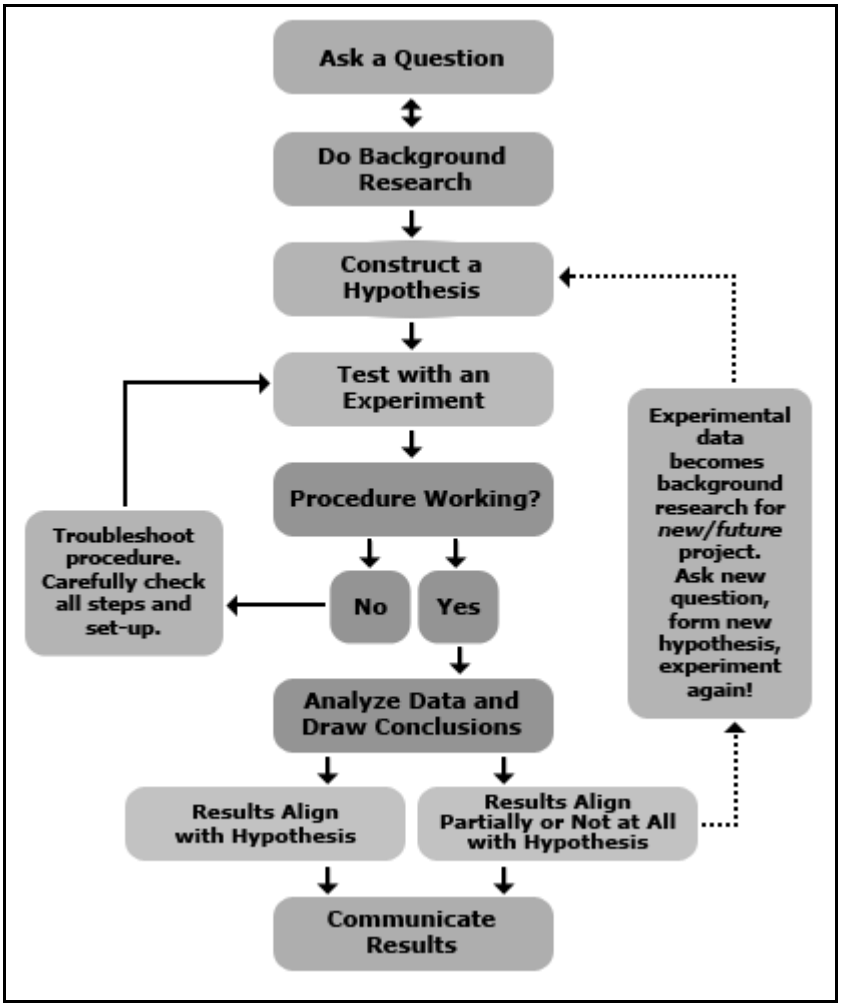
Keywords:

Analysis Methodology, Scientific Process and Science Research

12.1 Introduction:

The scientific method is an experimental process which explores and answers observations. Does this mean that all scientists are following this method exactly? No, not so. Some fields of science can be checked more quickly. For example, scientists who research how stars evolve as they grow old and how dinosaurs have digested their food will be unable to quickly pursue a star's life by a million years. If direct observation is not feasible, researchers change the scientific method. Indeed, the scientific method probably exists as many versions as scientists! However, the purpose remains the same even when modified: the discovery of causes and effects by queries, the collection and the examination of proofs, and the combination of all the available knowledge to a reasonable answer. Even though it is a series of steps that demonstrate the scientific method, remember that a scientist can at any point during the process provide support and repetition of knowledge or thought. An iterative process is called a process such as the scientific method which involves such support and repeating. When doing a science fair project, a science class, independent research or any other practical scientific research that is aware of the steps of the scientific method, you can concentrate your scientific question and work to address the question as closely as possible through your findings and data. It is important to understand that theory-building and theory-testing are both critical to scientific advancement (inductive research) and theory-testing (deductive research). Unless they fit truth, elegant ideas are not useful.

Similarly, mountains of data are worthless unless they can help build concrete theories. Instead of looking in a circular relationship at these two processes as shown in Figure 3, they can be more accurately seen as helix, since each isolation between theory and data contributes to a better understanding of interest phenomena and better theories. Although inductive and inductive research is important for the promotion of research, it seems that inductive research (theory building) is more valuable when there are little theory or explanation, whereas deductive research (theory testing) is more productive if there are several competing theories of the same phenomenon, and researchers want to know which theory works best.



12.2 Steps of the Scientific Method:

A. Ask a Question: The scientific method begins by asking yourself a question: How, When, Who, When, Why, or Where?

B. Do Background Research: You want to be a skilled researcher using library and online research, not beginning at all in developing a strategy to address your question, but helping you find the best way to do things and ensuring you do not make mistakes in the past.

C. Construct a Hypothesis: An informed guess about how things work is a hypothesis. It is an attempt to provide an explaining to answer your question. Then you can make a guess in a strong hypothesis:

"If _____ [I do this] _____, then _____ [this] _____ will happen."

D. Test Your Hypothesis by Doing an Experiment: Your experiment tests whether your prediction is correct, which supports or not your hypothesis. It's necessary to be a reasonable

test for your experiment. You conduct a fair test by ensuring that all the rest of the conditions are the same are changed just one factor at a time.

E. Analyze Your Data and Draw a Conclusion: Once the experiment is over, the measurements are collected and analysed to see whether or not they support your hypothesis.

F. Communicate Your Results: You will inform the others in a final report and/or a display board to complete your science fair project. By posting the final report on a science journal or by sharing their findings on a poster or during a discussion at a scientific conference, professional scientists are almost exactly the same. Judges are interested in your conclusions at a scientific fair, whether or not they accept your original hypothesis.

12.3 Scientific Method:

In the previous sections, we defined science as scientific knowledge. So what is the 'scientific method,' exactly? The scientific method refers to systematic techniques for the development, such as how objective observations can be made, how results can be interpreted and how these results can be generalized.

The scientific method enables researchers to evaluate current hypotheses and previous observations objectively and impartially and subject them to open discussion, revisions or improvements. Four characteristics must be met by the scientific method:

- **Replicability**: Close if not identical findings can be obtained from other people to reproduce or duplicate a science study independently.
- **Precision:** Theoretical concepts that are often difficult to quantify must be described so precisely that other definitions may use them for the measurement and testing of these concepts.
- **Falsifiability:** A theory should be set out in such a way as to disprove it. Untested or falsified theories are not scientific theories, nor are such knowledge scientific knowledge. A theory defined in incorrect terms or the principles of which cannot be precisely measured is therefore not scientific and cannot be evaluated. The psychoanalytic ideas of Sigmund Freud fall in this group and are not therefore considered a
- **Parsimony:** When multiple explanations for a phenomenon exist, scientists must always consider the explanation which is obvious, or logically the most economical. This is known as parsimony or "Occam’s razor." Parsimony prohibits scientists from following excessively complicated or obscene ideas of endless definitions and connections that describe a little but nothing in particular.

Any branch of research that does not permit the scientific method to test its fundamental laws or theories cannot be referred to as 'science.'

For example, theology (the study of religion) does not represent a scientific field because theological ideas (like the existence of God), using a replicable, accurate, fake and parsimonious system, cannot be checked by objective observers.

Likewise, even though they are self-creative and worthwhile endeaktions, arts, music, literature, humanities and law are not considered science.

12.4 Postulates of Scientific Method:

The scientific method is therefore based on certain fundamental postulates underlying:

1. It is based on empirical proof;
2. It uses concepts that are relevant;
3. It has only objectively considered;
4. It presupposes ethical neutrality, that is, aims to only make appropriate and accurate statements about the objects of the population;
5. It leads to probabilistic predictions;
6. Its methodology is used to evaluate the findings by way of replication by all concerned for critical scrutiny;
7. It is designed to develop most general axioms or so-called scientific theories.

"The scientific method thus promotes a systematic, impersonal procedure determined by logical and objective process requirements." Therefore, the scientific method involves a method that is objectives, logical and systematic, i.e. a way that is free of personal partiality or prejudice, a way of identifying demonstrable properties of an event that can be checked, a method that leads to a researcher's logical reasoning, a way where the study goes unordered and a method that implies a method which involves a method of inner understanding

12.5 Scientific Research:

Since scientific research works on two levels - the hypotheses and findings - theory and the empirical level. Scientific research is based on two levels. The theoretical level focuses on the development of abstract ideas regarding natural or social phenomenons and their connection (i.e., build "theories"), while the empirical level examines the theoretical concepts and relationships to see how well they match our observations of reality, in order to finally establish better theories. A theory has been improving over time and the science has become more mature (i.e. best fits the observed reality). Scientific research means constantly reversing hypothesis and findings. Theory and findings also constitute basic elements of scientific study. For example, it is not considered a legitimate scientific study to rely solely on observations to conclude and to ignore theory.

Scientific inquiry may take one of two possible forms, depending on the training and interest of researchers: inductive or deductive. In inductive analysis, a researcher's aim is to deduce observations from theoretical principles and patterns. In deductive investigations, the researchers' objective is to use the latest empirical evidence for testing theories and patterns known from theory. Inductive research is also often referred to as research to construct theory, and inductive research is research that tests theory.

Note here that it is not simply a matter of testing a theory, but perhaps of refining, improving, and extending that theory. Figure 1.1 shows the inductive and inductive analysis complementary existence. It should be noted that the two halves of inductive and deductive analysis are continuously induced by the theory and observations. Unless you are familiar with the theory and data components of science, you cannot do inductive or deductive research. Of course, a full researcher will go through the whole cycle of study and conduct inductive and deductive research.

It is important to understand that theory-building and theory-testing are both critical to scientific progress (deductive research) and theory-testing. Unless they fit truth, elegant ideas are not useful. Similarly, mountains of data are worthless unless they can help build concrete hypotheses. Rather than looking at these two processes in a circular relation, as shown in Figure 1.1, they can be viewed better than a helix, with each iteration among theory and data helping to clarify the phenomenon and better theories. While both inductive and deductive studies are important for the promotion of science, inductive (theory-building) research seems more valued when there are few prior theories or explanations and deductive (theory-testing) studies are more productive if many competing theories of the same phenomenon are found and researchers want to know which theory works best.

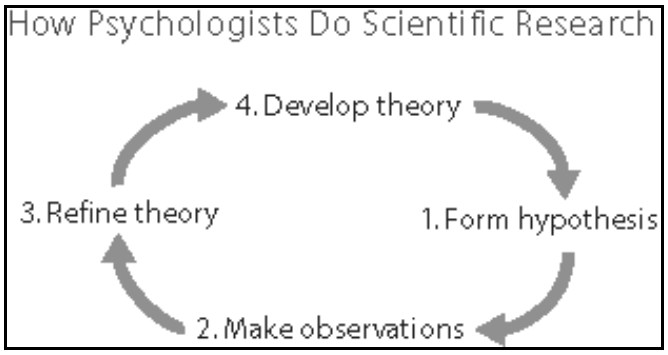


Figure 12.1: The Cycle of Research

Therefore, it is essential to conduct scientific research on two skill sets – theoretical and methodological – which must work at the theoretical and empirical levels. The methodological abilities ("know-how") are relatively normal, invariant and easy to gain in doctoral programmes through various disciplines.

However, it is considerably harder to master theoretical abilities ("Know what"), it takes years of observation and thought, and implicit competencies, which cannot be "learned."

12.5.1 Types of Scientific Research:

Scientific research projects can be classified in three categories, according to the intent of research: exploratory, descriptive and explanatory. Exploratory investigations are also undertaken in new fields of study with the aims of:

a. The degree or scope of a specific phenomenon, problem or behavior can be determined
b. To generate some first ideas about the phenomenon (or "hunches");
c. In order to test whether a more thorough analysis of this phenomenon is possible.

In a country where governmental policies related to the economic recession are not generally satisfactory, for example, exploratory research should focus on measuring the extent of citizen dislike, the extent to which such satisfaction occurs, such as the prevalence of public protests, and the alleged reasons for such disappointment including ineffective governance. Interest rates, unemployment, or higher taxes.

This could involve an analysis of statistics previously published, such as the economic indicator estimates (GDP), unemployment and the price index for consumers archived by third-party outlets, collected from interviews with experts, eminent economists or key government officials, and/or extracted from historical examples of coping with similar problems. This study does not lead to a very precise comprehension of the problem, but it can be useful in the scope and scope of the problem and can act as a useful precursor for further studies.

Descriptive analysis aims at careful observations and thorough recording of an interesting phenomenon. These findings must be focused on experimental methods (i.e. replicable and accurate, etc.), which is therefore more credible than untrained people's casual observations. They use the same or similar measures in several job surveys or censuses to estimate jobs by sector or population growth by ethnicity. Where adjustments are made to the measuring devices, the calculation is given with and without the device being adjusted so that readers can compare their population and employment trends fairly before and after. Other research descriptors may include chronicling ethnographical reports about adolescent youth activities in urban areas, the persistence or development by selected groups of religious, cultural or ethnic practices, and the role of technologies such as Twitter and instant messaging in the spread of democratic movements in countries of the Middle East. Explanatory analysis attempts to explain the phenomenon, issues or behavior observed. Descriptive research explores what a phenomenon, where it is and why it is, and explanatory research looks for answers about why and how questions are asked. It tries to "connect the dots" by defining causal factors and results of the target phenomenon. Examples include identifying why youth crime or gang violence is committed to prescribe solutions to solve these social disturbances. Most academic or doctoral research fall under the explanatory category, although some study and/or description may also be needed during initial academic research phases. Strong theoretical and analysis skills along with perspective, observations and personal experience are essential to seek explanations for observed events. The best scientists in their fields are just those who can do it well

12.5.2 Procedures for Scientific Research: (Major Steps in the Research Process)

Research should be conducted according to plan, system and logic. The emphasis is on a sophisticated and systematic approach that distinguishes research from other less comprehensive knowledge collection practises or problem solving, such as trial and error. For conducting and reporting scientific research, the following steps are recommended:

A. Formulation of the Research Problem: Most new researches begin with the formulation of a general problem of research and with questions of basic importance about the topic of research. This will generate excitement about defining the key points of the investigation properly.

B. Review of Relevant Literature: A critical study of current works in an area under research is a literature review. The critical component of this concept requires the reviewers to detect contributions in the field and to recognise existing shortcomings or weaknesses. The analysis offers an insight or scenery for study and says that the researchers are still not dead end and believes one of the principal functions of a synthesis of relevant literature is to let the reader know that the researcher is well acquainted with existing research materials on this topic. The existing state of knowledge on the topic also is clearly shown.

C. Formulation of Research Hypotheses: The researcher will eventually come to a fundamental formula for the analysis by making provisional assumptions or statements of the relationship between two or more variables. In all scientific study, research hypotheses are quite important (especially in quantitative research).

D. Determination of the Research Design: The method or strategy that guides the data collection for this study is described in this stage of scientific research.

E. Sampling methods and Sample Selection: Samples are chosen using statistical means to ensure that the topic concerned is selected evenly and also to prevent partiality in the collection. Representatively is crucial because the results of the research obtained from the collection of samples are used to generalize their influence on the entire population.

F. Data Collection Techniques: Data collection is the data collection method for the study research, from primary or secondary sources. The main sources are first-hand knowledge or raw data that the researcher obtains himself through the management of research instruments. The secondary sources are current information derived from specific materials such as books, journals, magazines, etc., as well as useful materials accessible to the researcher. List two major research data collection techniques: *survey methods and non-research methods.*

G. Methods of Data Analysis and Presentation: As statistical analysis are carried out on the data, and it is structured in an understandable fashion, the field of study is expanded once more. Via these responses the study is further expanded, exposing some patterns and answers to the initial questions. Analysis can be described as the breakdown and arrangement of the quantitative data gathered for analysis. It also includes the quest for interaction trends and patterns and relationships between these data or groups of data.

H. **Discussion and Interpretation of Findings:** This move addresses theoretical discussions on the data and knowledge derived from the analysis. The debate focuses on the conclusions and comparative interpretation of the data and expectations;

It corroborates or rejects previous positions in the literature examined, examines how it was possible to fill the gaps in knowledge and human development made by the present study. See the central component and one of the most important aspects of the research method of interpreting research results. If its result cannot be correctly evaluated and interpreted, a study method is useless for policy making or planning.

I. **Writing the research Repor**t: A report shall constitute a formal declaration, written by an individual or body charged to do so, of the results of science study or research, or of any topic on which certain information is needed. The writing of reports is a specific communication medium and is of various styles and types. Other forms are study or survey reports, such as those used in both academic, commercial and business environments, apart from the form report needed by students in examinations for a strictly specific reason.

There are short, long and very long reports that vary from basic and relatively complex to technical reports for analysis and business purposes. Therefore, a successful report must be fully readable and formal. The terminology used must comply with the anticipated body standard and style or tradition.

J. Summary, Conclusion and Recommendations: This includes a brief overview of the entire work. It highlights key observations, implications for the current situation and further study, the formulations of policies and their application and theoretical consequences. The results of the study draw the inference and this constitutes the subject of the policy proposals and the effects. Recommendations are also taken on the basis of the study's projections and predictions.

12.6 Writing a Research Paper Using the Scientific Method:

a) **Problem:** In the problem, you have to tell us what your research is about. It is in the form of a query to be written. The intention of this type of research paper should also be explained. These are the questions you would like to answer about your subject, in other words.
b) **Research:** This is when you find more information and questions about your subject. Using a graphical organizer to arrange it later. 3. HYPOTHESIS – That's why, in your opinion, you'll justify the answers you said earlier. You can now plan how you answer questions about your subject for your article.
c) **Experiment:** This is the rough stage of the draught. You will write, read and modify your document, as required, until good flow and good information are available.
d) **Analyze:** You'll edit your paper here. See your questions to ensure that they are all answered or adjusted. See your research for fact-based and clearly articulated knowledge which is included.
e) **Conclusion:** The last section of the paper. Here you can combine anything and have your own thoughts about what you have heard. Make sure that all your material is provided and well communicated to the reader.

12.7 References:

1. Sahu P.K. (2013) Scientific Process and Research. In: Research Methodology: A Guide for Researchers in Agricultural Science, Social Science and Other Related Fields. Springer, India. https://doi.org/10.1007/978-81-322-1020-7_1
2. Journal of Young Investigators. 2005. Writing scientific manuscripts: a guide for undergraduates. Journal of Young Investigators, California.
3. Lanciani, C. A. 1998. Reader-friendly writing in science. Bulletin of the Ecological Society of America 79: 171–172.
4. Morris, J., T. Jehn, C. Vaughan, E. Pantages, T. Torello, M. Bucheli, D. Lohman, and R. June. 2007. A student's guide to writing in the life sciences. The President and Fellows of Harvard University, Massachusetts.
5. Schimel, J. 2012. Writing science: how to write papers that get cited and proposals that get funded. Oxford University Press, Oxford.
6. Klinik araştırmalar Derneği. Helsinki Bildirgesi. 2016. The web site: http://www.klinikarastirmalar.org.tr/icerik.phpid
7. Bekiroğlu N. Biyoistatistik. The web site: http://docplayer.biz.tr/2029485-Biyoistatistik-nural-bekiroglu-ph-d-giris.html.
8. Sessler D, Imrey PB. Clinical Research Methodology 3: Randomized Controlled Trials. Anesth Analg.
9. Özkan S. İlaçlarla yapılan gözlemsel çalışmalar. In: Akan H, İlbars H, Ömeroğlu Çetinkaya N, editors. Klinik Araştırmalar Kitabı-2014 1 Baskı. Ankara: Bilimsel Tıp Yayınevi; 2014.

10. Karl R. Popper, Conjectures and Refutations: The Growth of Scientific Knowledge, Routledge, 2003
11. Gauch, Hugh G. Jr. (2003), Scientific Method in Practice, Cambridge University Press
12. Jevons, William Stanley (1874), the Principles of Science: A Treatise on Logic and Scientific Method.
13. Punch, K. (2006): Survey Research: the basics Sage, London reference collections Shelfmark.
14. Asika, N. (1999): Research Methodology in Behavioral Sciences. Lagos: Longman Nigeria Plc.

ISBN: 978-93-90847-07-5

Chapter - 13 : Multicollinearity and Multivariate Linear Regression: The Consequence, Diagnostics and Remedies

Dipen Roy

Professor of Commerce, University of North Bengal, India.

13.1 Introduction:

In the socio-economic perspective, almost every variable is subject to influence of multiple other variables. For example, simply weight of a group high-school students, studying in a class, does not depend on age alone. Besides age, it depends on heredity, height, family income, nutrition, physical exercise, etc.

Likewise, the relationship of a macroeconomic variable with its predictors is not a simple bi-variate relation. Contrary to this, many of the economic relationships are multi-variate relationships. For example, GDP is a function of multiple explanatory variables such as size of FDI (X_1) inflow, domestic capital formation (X_2), foreign trade (X_3), governmental expenditure (X_4), foreign aids (X_5) and many other variables. Thus, a researcher begins his research with a hypothetical relationship, expressed as below:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + e_t$$

Where Y is the dependent variable and X_is are multiple predictors (explanatory variables) explaining increase of Y. The coefficient β_i is the sensitivity of the variable i. This initiates the beginning of a multivariate analysis.

The relationship stated above stands valid only when all the assumptions of OLS are duly satisfied. One of the assumptions of OLS requires that the explanatory variables X_1, X_2, X_3, X_4, etc., should not be linearly correlated with each other. If the explanatory variables X_1, X_2, X_3, X_4, etc., appear linearly correlated with each other, the phenomenon is defined as multicollinearity, which takes a researcher to a paradoxical situation [Zikmund, W.G., et al (2016)]. In this paper we propose to unfold the paradoxical situations confronted by a researcher with simple numerical examples. This is supposed to enable the researchers to take appropriate precautions before drawing the final inference from a model.

In short, the explanatory variables should be orthogonal, meaning not related with each other. However, in practice, many of the explanatory variables (predictors) move together in an inter-related fashion. Agricultural production, industrial production, consumption, income tax collection and many other macro-variables move together, at least, in terms of direction.

In other words, when there is up (boom), there is up; when there is down (recession), there is down. This makes many macro-variables become inter-correlated with each other. This is the root cause behind the multicollinearity of time-series data.

Multi-collinearity is not necessarily limited to time-series data. It can occur in cross-section data, as well, when the explanatory variables have inherent causal relationship.

13.2 Consequences of Multicollinearity:

While analyzing multivariate data, researchers focus lies on the determination of the estimates of the coefficients β_1 β_2, β_3, etc.

Theoretically, the presence of perfect linear relationship between the explanatory variable makes the parameters β_1 β_2, β_3 etc undefined. Using a simple hypothetical relation, consisting of two explanatory variables X_1 and X_2, we show how the coefficients become undefined.

Say the hypothetical relationship is written as below:

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2$$

The formula of β_1 is

$$\beta_1 = \frac{(\sum x_1 y)(\sum x_2{}^2) - (\sum x_2 y)(\sum x_1 x_2)}{(\sum x_1{}^2)(\sum x_2{}^2) - (\sum x_1 x_2)^2}$$

We propose to examine how β_1 becomes undefined. We presume that there is a linear relationship between X_1 and X_2. The said relationship is represented by $X_2 = kX_1$. While writing kx_1 for x_2 in above equation, the formula gets transformed as below:

$$\beta_1 = \frac{k^2(\sum x_1 y)(\sum x_1{}^2) - k^2(\sum x_1 y)(\sum x_1 x_1)}{k^2(\sum x_1{}^2)(\sum x_1{}^2) - k^2(\sum x_1 x_1)2}$$

$$\beta_1 = \frac{k^2(\sum x_1 y)(\sum x_1{}^2) - k^2(\sum x_1 y)(\sum x_1{}^2)}{k^2(\sum x_1{}^2)^2 - k^2(\sum x_1{}^2)^2} = \frac{0}{0}$$

That is, presence of multi-collinearity renders the coefficients β_1 undefined. This is true in case of β_2 as well. It makes multivariate analysis becomes meaningless. However, the escape is that, in reality, the correlation coefficient between two explanatory variables is neither perfect ($r = 1$), nor zero.

It lies between the two, i.e., $0 \leq r \leq 1$. As the degree of correlation between explanatory variables increases the regression coefficients continues to become unstable.

In the words of Field, Andy (2016) presence of multicollinearity makes the coefficients almost unreliable. In the words of Koutsoyiannis, A. (1996) the coefficients become unstable, as sample size is increased or more correlated variables are incorporated into the model.

Field Andy (2016) observes the consequences of multicollinearity on three different aspects of multivariate analysis. These are value of the coefficients β_1 β_2, β_3 etc., measure of goodness of fit R^2 and sensitivity of the predictors. Firstly, the author points that the coefficients β_1 β_2, β_3 etc. appear unreliable. Secondly, the goodness of fit, R^2 remains unaffected even when the extra predictors are added to the model or withdrawn from the model. These two points have been explained with a case of numerical example in the following paragraphs.

13.3 Advertisement and R&D Expenditure: A Case of Multicollinearity

Consider the data on 'Sales Revenue, R&D and Advertisement' given in the table below (**Table 1**). We begin with a belief that advertisement and R&D add to the sales revenue of the firm. Therefore, advertisement and R&D are predictors, while sales revenue is the dependent variable. For computing the regression coefficients, it requires us to assume that there is no relationship between R&D and Advertisement. However, we have taken a data-set, where the predictors, advertisement and R&D, are linearly correlated. The purpose of this example is to bring to light the consequences of multicollinearity.

Table 13.1: Measuring the Impact of R&D and Advertisement on Sales Revenue

	Figures are in $ billion									
Advertisement	10	12	11	10	13	15	19	21	22	26
R&D Outlay	3	4	3	3	4	5	6	7	7	8
Sales Revenue	45	50	47	54	50	59	62	65	66	73

We begin with estimating the relationship of sales with individual predictors, advertisement and R&D, separately. When multicollinearity is fully absent, the coefficient of a predictor obtained from simple regression becomes almost equal to the coefficient of the predictor obtained from a multivariate regression. However, presence of multicollinearity gives a misleading result. We propose to verify this from the analysis of subsequent paragraphs. Definitely, our calculation is based on the data given above in **Table 1**.

Table 13.2 Shows the Coefficient Table of Simple Relationship of Sales with Advertisement.

Table 13.2: Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	32.341	2.917		11.088	.000
	ADV	1.557	.174	.954	8.967	.000
a. Dependent Variable: SALES						

The coefficient of advertisement is statistically significant. It means that advertisement has strong influence on sales. Goodness of fit of the model is 91%. In short, the equation of sales on advertisement can be written as below

$$SALES = 32.34 + 1.557(ADV) \qquad R^2 = 0.91$$

t - Statistic (11.08) (8.96)

While computing simple regression equation of sales on R&D, we find the following output as shown in Table 13.3

Table 13.3: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	33.506	2.744		12.209	.000
	R&D	4.719	.517	.955	9.131	.000
a. Dependent Variable: SALES						

The result as shown in **Table 13.3** reflects that the coefficient of R&D is statistically significant. In other words, there is strong influence R&D on sales. Goodness of fit is 91%. In short, the equation of sales on R&D can be written as:

$$SALES = 33.50 + 4.719(R\&D) \qquad R^2 = 0.91$$

t - Statistic (12.21) (9.13)

In practice, it is found that every success of R&D requires the company to make an additional advertisement to address the audience about the new features of the product.

So, a higher the level of expenditure on R&D, higher is the level of advertisement expenditure.

That is, two explanatory variables are linearly correlated with each other. Actual measure of correlation between two predictors, advertisement and R&D is 99%.

Now we propose to incorporate both the predictors in a single model and study the consequences of multicollinearity. On the line of the relationship such as $Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2$, we initially write that

$$SALES = \beta_0 + \beta_1 (ADV) + \beta_2 (R\&D)$$

The SPSS output of multiple regression is briefly stated as below:

$$SALES = 33.50 + 0.63ADV + 2.82(R\&D) \qquad R^2 = 0.91$$

t - Statistic (10.45) (0.45) (0.67)

Table 13.4 shows the ANOVA table and Table 5 presents the table of the coefficient. These are obtained as elements of SPSS output.

Table 13.4: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	714.492	2	357.246	37.657	.000[b]
	Residual	66.408	7	9.487		
	Total	780.900	9			

a. Dependent Variable: SALES

b. Predictors: (Constant), ADV, R&D

Table 13.5: Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	32.937	3.151		10.453	.000
	ADV	.633	1.391	.387	.455	.663
	R&D	2.821	4.210	.571	.670	.524

a. Dependent Variable: SALES

The findings (Table 13.4 and Table 13.5) are really puzzling, because the regression is statistically significant, because ANOVA table indicates that F is statistically significant (much better than 1% level); however, the coefficients of the predictors, advertisement and R&D, are statistically insignificant. Now on the basis of above three outputs, we can summarize the observations as below:

a) Firstly, the coefficients of the predictors, advertisement and R&D, obtained from multivariate regression are much lower (See Table 13.5) compared to the corresponding values obtained from simple regression analysis.
b) The coefficients of the predictors in the coefficient table of multiple regression (see Table 13.5) are statistically insignificant, while the corresponding coefficients were significant in the outputs of simple regression, where we assessed the effect of individual predictor on sales separately.
c) Thirdly, goodness of fit, R^2 is same in all three outputs. It shows that if there is perfect multicollinearity, addition of linearly correlated variables does not improve the goodness of fit.
d) Standard Errors of the coefficients obtained in multiple regression analysis are several times higher than their original Standard Errors. This point is discussed in greater details in the following paragraph.

13.4 Multicollinearity and Standard Error of Coefficients:

Theoretically, presence of multicollinearity magnifies the size of Standard Errors of the coefficients. The same can be proved as below:

$$\text{Var}(\beta_1) = \frac{(\sum x_2^2)}{(\sum x_1^2)(\sum x_2^2) - (\sum x_1 x_2)^2}$$

$$= \frac{k^2 \sum x_1^2}{k^2 (\sum x_1^2)^2 - k^2 (\sum x_1^2)^2} = \frac{k^2 \sum x_1^2}{0} = \infty$$

Standard Error (β_1) = $\sqrt{Var(\beta_1)} = \infty$

Table 13.6: Multi-collinearity and the Stand Error of the Coefficients:

Simple Regression		**Multiple Regression**	
Predictor	Standard Error(β_i)	Predictor	Standard Error(β_i)
Advertisement	0.174	Advertisement	1.39
R&D	0.517	R&D	4.21

Table 13.6 reflects that the Standard Errors of the coefficients shown under multiple regression column are several times higher than the corresponding standard errors obtained in simple regression analysis. In an ideal situation, while there would exists no multicollinearity, the coefficients of the predictors and their corresponding Standard Errors, as obtained from simple regression analysis would remain identical with their corresponding values computed from multiple regression model. In other words, in the absence of multicollinearity the results of simple regression analysis and those of the multiple regression analysis would be identical. Unfortunately, this did not happen in our analysis. Existence of Multicollinearity results in exaggerated value of Standard Error of the regression coefficients, which leads to abnormally lower value of the computed t-statistic. This leads the researcher to infer that regression coefficients are statistically insignificant, even though the goodness of fit of the regression is quite satisfactory (*accepted through F-Test*).

Table 13.7: Collinearity and Goodness of Fit

Influence of	**Regression Equation**	**Goodness of Fit**
ADV on SALES	SALES = 32.34 + 1.557(ADV)	$R^2 = 0.91$
R&D on SALES	SALES = 33.50 + 4.719(R&D)	$R^2 = 0.91$
ADV and R&D on SALES	SALES = 33.50 + 0.63ADV+ 2.82(R&D)	$R^2 = 0.91$

Table 13.7 compiles R^2 values obtained in different trials of assessing the effects of Advertisement and R&D on sales. Surprisingly, R^2, the goodness fit, remains unaffected (R^2 = 0.91) in all three trials. It means multicollinearity does not reduce or increase the goodness of fit. Addition or withdrawal of a similarly correlated variable leaves no effect on goodness of fit.

13.5 The Gravest Consequence of Multicollinearity:

Now we propose to take another example with time-series data. The table (**Table 13.8**) contains data relating to five variables. To note, here X_1 is dependent variable and remaining other variables X_2, X_3, X_4 and X_5 are predictors. This example will draw attention to the gravest consequence of multicollinearity.

Table 13.8: Linearly Correlated Predictors: Time-series Data

Year	X_1	X_2	X_3	X_4	X5
1	23.31	15.05	30.38	25.21	18.88
2	32.98	16.24	27.15	22.6	16.71
3	10.37	21.92	31.48	11.66	17.07
4	48.48	32.69	39.99	25.55	10.69
5	20.17	37.02	45.19	34.68	29.68
6	-17.6	17.48	23.59	22.27	22.14
7	6.11	10.31	11.72	1.27	7.79
8	19.06	8.29	10.36	3.24	7.26
9	18.65	6	6.38	0.12	2.83
10	1.87	9.93	10.36	12.61	6.41
11	-6.58	6.85	6.36	10.4	6.5
12	3.36	2.58	1.53	3.96	-2.31
13	1.07	6.87	7.33	13.87	10.46
14	36.51	14.75	18.4	20.93	10.08
15	50.98	18.56	24.27	23.05	19.34
16	41.36	25.12	30.96	18.5	22.46
17	35.37	26.73	32.66	35.2	32.39
18	10.46	27.82	31.64	21.96	30.57
19	27.1	17.38	19.92	7.67	14.83
20	11.26	18.95	19.94	15.25	20.09
21	18.17	14.14	14.47	16.34	22.3
22	6.45	10.07	10.16	1.36	18.11
23	12.79	7.92	6.1	3.67	14.24

Year	X_1	X_2	X_3	X_4	X5
24	-3.25	8.08	7.58	7.5	7.47
25	13.77	6.73	5.92	2.41	5.3
26	-3.09	12.12	11.21	5.23	-2.03
27	-4.91	8.86	8.97	15.65	7.4
28	6.96	6.08	5.14	1.28	7.34
29	12.48	8.39	7.79	21.74	11.66

One of the methods of detecting multicollinearity is scanning the correlation matrix. Looking at the correlation matrix [See Table 13.9], it is observed that the variables X_2, X_3, X_4 and X_5 are strongly correlated with each other. Hence, this analysis is undertaken with the advance information that there is multicollinearity. Our objective is to point to the worst consequence that multicollinearity can produce. We adopt the approach called management by exception, i.e., learning from the mistakes.

Table 13.9: Correlation Matrix

		X_1	X_2	X_3	X_4	X_5
X_1	Pearson Correlation	1	.521**	.556**	.462**	.349*
	Sig. (1-tailed)		.002	.001	.006	.032
	N	29	29	29	29	29
X_2	Pearson Correlation	.521**	1	.962**	.771**	.749**
	Sig. (1-tailed)	.002		.000	.000	.000
	N	29	29	29	29	29
X_3	Pearson Correlation	.556**	.962**	1	.805**	.742**
	Sig. (1-tailed)	.001	.000		.000	.000
	N	29	29	29	29	29
X_4	Pearson Correlation	.462**	.771**	.805**	1	.723**
	Sig. (1-tailed)	.006	.000	.000		.000
	N	29	29	29	29	29
X_5	Pearson Correlation	.349*	.749**	.742**	.723**	1
	Sig. (1-tailed)	.032	.000	.000	.000	
	N	29	29	29	29	29

We want to begin with a simple regression equation of two variables, one predicted and the other a predictor. We take X_2 is a predictor of X_1. Table 10 shows the coefficient table obtained from regression output of X_1 on X_2.

Based on the entries of Table 13.10, we construct the following equation.

$$X_1 = 0.178 + 1.013\ X_2 \qquad R^2 = 0.27$$

t - Statistic (.033) (3.173)

Table 13.10: Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	.178	5.394		.033	.974
	X2	1.013	.319	.521	3.173	.004
a. Dependent Variable: X1						

The result shows that X_2 has a positive influence on the value of X_1. As per indications of ANOVA table (not shown here), the regression is statistically significant (at 1% level).

Subsequently, we add X_3 and X_4 to the model. Table No 11 shows the Coefficient Table. It shows a negative coefficient for X_2.

This coefficient was positive in simple regression output, shown in Table 13.10. But with addition of new variables, it turns negative. This is the gravest consequence of multicollinearity. Table No 12 shows the Coefficient Table, when all four collinear variables are introduced.

Table 13.11: Three Predictors' Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	1.817	5.740		.316	.754
	X2	-.335	1.176	-.172	-.285	.778
	X3	.977	.921	.689	1.060	.299
	X4	.068	.468	.041	.145	.886
a. Dependent Variable: X1						

Table 13.12: Four Predictors' Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
1	(Constant)	2.407	5.899		.408	.687
	X2	-.181	1.219	-.093	-.148	.883
	X3	.972	.933	.685	1.041	.308
	X4	.166	.502	.099	.331	.744
	X5	-.302	.505	-.162	-.598	.556
a. Dependent Variable: X1						

This is needless to say that in case of each output, in the light of ANOVA Table data, regression appeared significant. However, the paradox is that when we read all three tables [Table 13.10, Table 13.11 and Table 13.12] simultaneously, the coefficient of X_2 changes from 1.013 in Table 10 to - 0.335 in Table 13.11. It again changes to – 0.181 in Table 13.12 in the third trial.

In short, the coefficient of same predictor X_2 is fluctuating from one trial to another trial. Fluctuation is occurring to the coefficients of all other variables too (such as X_3 and X_4).

Koutsoyiannis (1996) points to this fact and states that the values of the coefficients become unstable as additional collinear variables are added to the model.

The very crucial drawback of multicollinearity is that the effect of an individual variable on the predicted variable gets eliminated by the influence of other linearly correlated variables.

As a result, measuring the marginal effect of changing a variable by one unit becomes thoroughly useless.

In other words, presence of multicollinearity makes it very difficult to assess the relative importance of a variable.

13.6 Multicollinearity Diagnostic:

Scholars can construct the correlation matrix to trace the presence of multicollinearity.

The presence strong correlation between the predictors is taken as the indication of the presence of multicollinearity. Second alternative is to look at the Standard Errors of the coefficients.

However, none of these criteria is a satisfactory indicator multicollinearity (Koutsoyiannis, A., 1996).

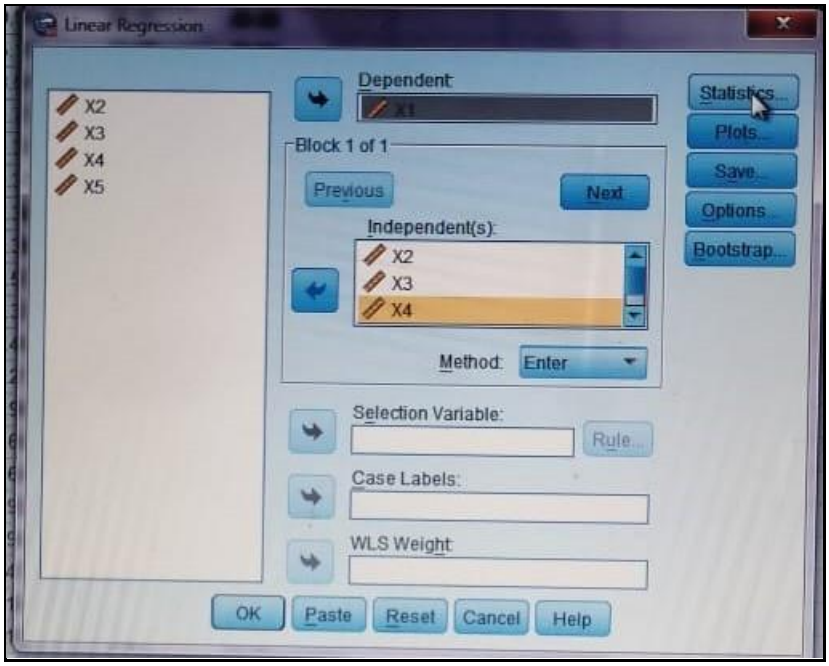
SPSS software provides two multicollinearity diagnostics called Variance Inflation Factor (VIF) and Tolerance; these are quite efficient as well as a globally recognized index for measuring collinearity. This comes to the great help of the researchers today.

The VIF indicates whether a predictor has strong linear relationship with other predictors.

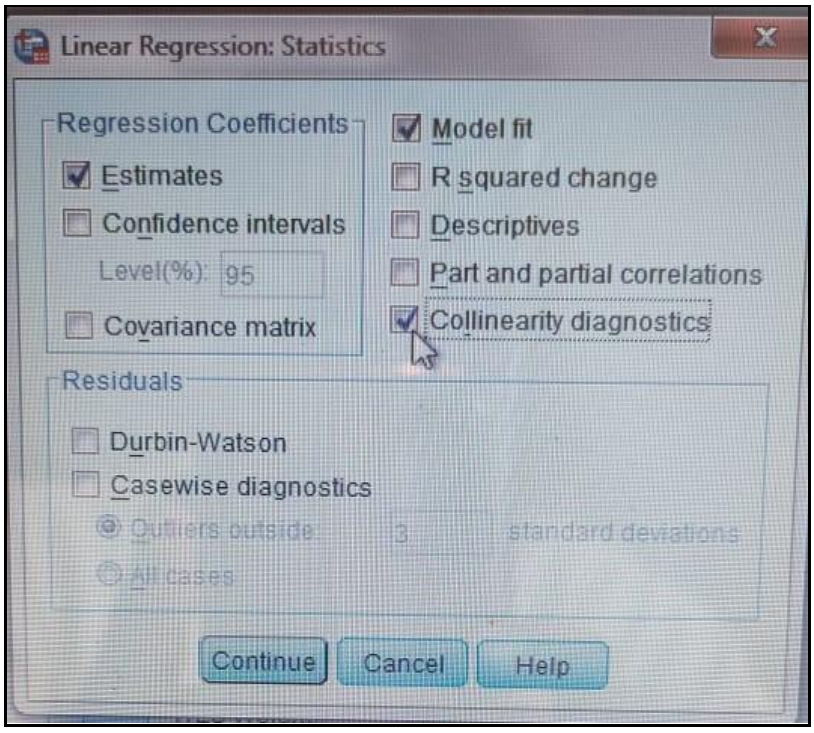
Given the computer is already loaded with SPSS, we demonstrate the steps involved in the process of conducting collinearity test.

While the data-set is ready, click on '**analyze**' located on upper menu bar, choose '**Regression**' from the list of analysis; then chose **'Linea**r' [In short, Analyse →Regression → Linear].

This will open the dialogue box of Linear Regression, a picture of which is given below:



This dialogue box requires a researcher to enter dependent variable and independent variables (predictors) in identified boxes. He is supposed to enter X_1 as dependent variable, remaining other predictors X_2, X_3, X_4 and X_5 as independent variable. Now making a click on OK is enough to get regression output. If the researcher wants to examine multicollinearity, he has to make a click on statistics, shown at the top right corner of the dialogue box above; it opens a dialogue box shown below:



Given the above dialogue box, the researcher is select collinearity diagnostics and run the regression model. This gives the following outcome (see Table 13.13) with full VIF indices corresponding to each coefficient.

Table 13.13: Coefficients [a]

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	2.504	5.916		.423	.676		
X2	-.198	1.222	-.102	-.162	.873	.072	13.924
X3	1.028	.931	.725	1.104	.281	.066	15.198
X4	.079	.483	.048	.164	.871	.338	2.963
X5	-.273	.504	-.146	-.543	.592	.390	2.561

a. Dependent Variable: X1

Table 13.13 shows two different indices for measuring multicollinearity. These are VIF and Tolerance. There is no consensus as to which value of VIF can be taken as the index of a serious degree of multicollinearity. Myers (1990) states that VIF equal to 10 is a limit of great concern. When VIF is less than 10, multi-collinearity is not likely to be hazardous. However, Hair J. F. et al (2010) states that VIF above 5 means there is multicollinearity. The rule of thumb is to take VIF equal to 5 as the cut-off point. It means if VIF is less than 5, the problem of multicollinearity is not severe.

Tolerance Level, which is defined as 1/VIF, can also be used to measure severity of multicollinearity.

Menard (1995) suggests that Tolerance Level below 0.2 is a matter of concern. It follows that as a rule of thumb we can accept VIF equal to 5 or Tolerance level 0.20 as the cut-off level. The both refers to the same cut-off level.

We propose to apply VIF equal to 5 as the cut-off limit to the output shown in Table 13. While we look at Table 13, the table of coefficients, we notice that variable X_2 and X_3 have VIF more than 5. While predictors X_3 and X_4 have VIF below 5. It means the predictors X_2 and X_3 (with VIF more than 5) should be dropped from the model, while predictors X_3 anmed X_4 can be retained. Some experts point to the question of relevance. If X_2 and X_3 are predictors of primary importance in the model, as price in a demand function, the problem becomes more difficult to handle. In that case, the researchers have to rely on other methods, rather than depending on Multiple Regression.

13.7 Remedies of Multicollinearity:

If VIF is within the cut-off limit, the limited degree of multicollinearity is not likely to affect the findings of the model. While some of the unimportant predictors have strong multicollinearity, those predictors can be dropped from the model without affecting the spirit of the model.

However, if multicollinearity has serious effects on the coefficients of the predictors of primary importance some solutions are to be explored. There are many methods of handling multicollinearity. Some of the simple and useful remedies have been enlisted below:

a. Increase the sample size: As sample size is increased, standard error of the coefficients continues to reduce; this enhances the values of t-statistic of the coefficients.
b. Principal Component Regression: This process involves transformation of group of linearly correlated predictors into an orthogonal factor, say F_1. Hence from a set of predictors a researcher may find two or three factors, which would be subsequently combined in a revised regression model, i.e., $Y = \alpha + \beta F_1 + \lambda F_2 + \gamma F_3$.
c. Using Additional Equation: Multicollinearity can be avoided by introducing an additional equation to the model by explaining the way predictors are related with each other. Say, $X_1 + 2X_3 + 0.5X_3 = 10$

Besides above, many other remedies are there. Interested readers can check textbook of Econometrics enlisted below.

13.8 References:

1. Bowerman, B. L. & O'Connell R. T. (1990). Linear Statistical Models: An Applied Approach, (2nd Ed) Belmont, CA: Duxbury.
2. Field, Andy (2009) Discovering Statistics using SPSS. Sage. Thousand Oaks, California.
3. Hair J. F., W. C. Black, B. J. Babin and R. Anderson (2010). Multivariate Data Analysis. Upper Saddle River, NJ: Prentice Hall, [VIF above 5 is a problem.].
4. Koutsoyiannis, a (1996). Theory of Econometrics. ELBS Macmillan, Hampshire, UK
5. Menard, S. (1995). Applied Logistic Regression Analysis. Sage University Paper Series on Quantitative Applications in Social Science. Pp.07-106, Thousand Oaks CA: Sage.
6. Myers, R. (1990). Classical and Modern Regression with Applications. (2nd Ed) Boston, MA: Duxbury.
7. Zikmund, W.G., Babin, B. J. Carr, J. C. Adhikari, A. Griffin, M. (2016) Business Research Methods: A South Asian Perspective, Cengage Learning India Private Ltd, Delhi.

List of Chapters

Kripa-Drishti Publications
A-503 Poorva Heights, Pashan-Sus Road, Near Sai Chowk,
Pune – 411021, Maharashtra, India.
Mob: +91 8007068686
Email: editor@kdpublications.in
Web: https://www.kdpublications.in

ISBN: 978-93-90847-07-5