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VARIABLES, HYPOTHESES AND STAGES OF RESEARCH¹

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Life span of different persons have been different. Physical abilities of different persons have been different. Marks of the students in the same subjects taught by the same teacher to all of them have been not equal. Temperature at different time in a day have been different. All these examples show that the variation in a characteristics is found per unit that possesses it. We can thus say that as a person, object or situation changes, value or proportion of the properties associated with it also changes. The characteristics that may change per unit is called variable. Variables play an important role in most of the researches, especially in quantitative type of researches in which numeric or quantitative data are gathered and analysed. Researcher must have clarity about the variables while conducting such a research because type of variable guides us to apply certain type of techniques for data analysis to test the hypotheses or to get the answers of research questions. Generally, variables are not considered in some of the qualitative type of research. We will discuss about the variables in detail in this chapter. Let's start with definitions of variable.

DEFINITIONS OF VARIABLE

Variable is concerned with variation in presence of something in person, object, animal, place or situation or in any natural phenomena. It can be defined as:

- A characteristic under study of which an identity or value changes or is possible to change per unit is called variable. **OR**
- A variable is a characteristic that varies in the context of its value or identity.

MEANING OF VARIABLE

Referring the definitions of variable, we can say that any such characteristic, possessed by any living or non-living unit or thing, is called variable whose value may change per unit or per groups of unit. Such characteristic is called variable characteristic in research study.

Some examples of variable are given below.

If we want to study the number of members in families of a village, the number of members will be variable characteristic, because value of this number will change per family and family will be considered as unit of study.

In the same way, if we want to study Mathematical Reasoning Ability (MRA) of students, MRA will be considered as variable characteristic and students will be considered as units of study.

Units of study is called subject in research study.

MEANING OF SUBJECT OF STUDY

The unit that possesses variable characteristic to be studied is called subject of study. Family, in our above mentioned first example, will be considered as subject and in second example student will be considered as subject of study.

In the same way, if we want to study Teaching Aptitude (TA) of high school teachers, the high school teachers will be subjects of our study and TA will be considered as variable characteristic under study.

Generally, in research studies, if variables are taken care of, interrelationship among the variables or impact of one or more variables on other variables is studied. Sometimes, interactive effect of some variables on other variable/s is studied through research. If variable based study is to be done through research activity, researcher must have the understanding of types of variable.

TYPES OF VARIABLE

There are five types of variable in terms of research methodology as follows.

Independent Variable

The variable, value of which affects the value of another variable is known as independent variable. Such variable is not affected by the change in the value of another variable but affects the value of another

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variable.

Generally, effect of such variable on another variable is measured or studied during research studies. Independent variable is also known as absolute variable.

We will understand this concept with the help of examples.

In a comparative study of Computer Aptitude (CA) of undergraduate students of different faculties, 'Faculty' will be considered as independent variable, because in this study researcher will check the impact of faculty on computer aptitude of the students. Faculty may have different levels like Arts, Commerce and Science. Here, researcher assumes that CA of students may differ from faculty to faculty. Each level of independent variable is called Stratum and all levels together are known as Strata.

In how many levels an independent variable is to be divided, depends upon how much large area is to be covered under study. If researcher wants to compare CA of Engineering and Medical students also in above mentioned study, there will be five levels of independent variable that is Faculty in this example.

Some independent variable, like Gender, has levels in fixed number. E.g. In the study of Emotional Maturity of students in terms of their Gender, the Gender will have only two levels Male and Female. Nowadays, third level of gender that is transgender is also accepted universally. In such cases gender will have three levels like Male, Female and Transgender.

As discussed earlier, generally, impact of independent variable on dependent variable is studied through research or dependent variable is studied in relation to independent variable. So, now we will discuss about dependent variable.

Dependent Variable

The variable, value of which may change due to change in the value of other variable is called dependent variable.

In other words, such characteristic is called dependent variable for which different values can be obtained in the context of change in independent variable.

In this way, we can say that value of dependent variable may change due to change in the value of independent variable.

Let's take an example to understand this concept.

In comparative study of Mathematical Reasoning Ability (MRA) of students in the context of their Intelligence, MRA will be dependent variable and Intelligence will be considered as an independent variable because in this study, the impact of Intelligence on MRA is to be checked. Researcher may divide the students according to level of their intelligence. Levels of intelligence may be high, low and medium or very high, high, medium, low and very low. Levels will be decided according to the need and objectives of study.

Generally, there has been relationship of cause and effect between dependent and independent variables, where independent variable acts as a cause and dependent variable as an effect. In our example, researcher takes intelligence as a cause and MRA as effect. Because, here, he wants to check whether MRA is affected by intelligence or not.

Let's take one more example to understand the relationship between dependent and independent variables.

Suppose we want to check the impact of teaching strategies like Concept Attainment Model (CAM) and Project Method (PM) on the achievement of students in Geography, then we will teach certain units of Geography to the students by these two strategies keeping in mind the procedure of experimental method. In this case, teaching strategy will act as a cause that can affect the achievement of students.

In real life, we find that a single characteristic is affected by more than one factors. In such cases, two or more variables may be there that may change the value of dependent variable. For example, achievement of students in any subject, may be affected by various factors like teaching strategy, intelligence, attention or understanding level and study habits of students. More factors may also be there. In such cases, researcher has to think over moderator variables also.

Moderator Variable

We know that independent variable affects the value of dependent variable and there has been cause and effect relationship between these two. The variable that affects the cause and effect relationship

between these two variables is called moderator variable. It means the effect of independent variable on dependent variable may be different in the presence of moderator variable.

E.g. In the study of Value Awareness (VA) of urban, rural and semi urban students, the area will be independent variable and VA will be dependent variable. But here, if researcher thinks that the gender of students may also affect the relationship between area and VA of students, the gender will be considered as moderator variable. Various moderator variables may be there for one pair of independent and dependent variable. Researcher has to decide, in such cases, which variable he wants to take as moderator variable.

If, in this case, researcher feels that Socio-Economic Status (SES) of students may also affect the relationship between Area and VA, he can take SES as second moderator variable. Final classification of variables, in case of two moderator variables in our example, will be as shown in *Table – 1*.

**Table – 1
Variable of Study**

Sr.	Variable	Type of Variable	Level/Strata of Variable
1	Area	Independent	1. Urban 2. Rural 3. Semi Urban
2	Gender	Moderator	1. Boy 2. Girl
3	Socio – Economic Status	Moderator	1. Higher 2. Middle 3. Lower
4	Value Awareness	Dependent	--

Researcher has to take extra care while selecting moderator variables. If sincere and proper care is not taken, important moderator variables will be ignored and useless variables will be selected.

If researcher does not want to check the effect of moderator variable, he controls it. Such control makes the variable controlled variable.

Controlled Variable

If the effect of such variables that can affect the cause and effect relationship of dependent and independent variable, is eliminated, it is called controlled variable.

In other words, if the effect of moderator variable is controlled, it is known as controlled variable.

E.g. In earlier mentioned example of study of value awareness, at last we have taken variables as shown in *Table – 2*.

**Table – 2
Variable of Study**

Sr.	Variable	Type
1	Area	Independent
2	Gender	Moderator
3	Socio –Economic Status	Moderator
4	Value Awareness	Dependent

If researcher defines a problem as ‘A study of Value Awareness of male students of urban, rural and semi urban secondary schools of Ahmedabad district’, the variable ‘Gender’ will become controlled variable, because in this case, he does not want to check the impact of gender on value awareness, as he will take only boys as sample. For this study, classification of variables will be as shown in *Table – 3*.

**Table – 3
Variables of Study**

Sr.	Variable	Type of Variable	Level/Strata of Variable
1	Area	Independent	1. Urban 2. Rural 3. Semi Urban
2	Socio –Economic Status	Moderator	1. Higher 2. Middle 3. Lower
3	Gender	Controlled	1. Male
4	Value Awareness	Dependent	_____

In this example, two controlled variables can also be taken. See the following research problem.

‘A study of Value Awareness of **male** students, having **High Socio-Economic Status**, of urban, rural and semi urban secondary schools of Ahmedabad district’

In this study, value awareness of Boys, who have High Socio-Economic Status only will be studied. So, both Gender and SES will become controlled variables, and classification of variables will be as shown in *Table – 4*.

We have discussed types of such variables till now, which can be clearly measured or taken care of during research. But some variables have been such that they either cannot be measured clearly or are to be ignored during the study, though they can affect the cause and effect relationship of dependent and independent variables. They are known as Intervening variables.

Intervening Variable

Any such variable is called intervening variable, that may affect the cause and effect relationship of dependent and independent variables but either cannot be measured clearly or is to be ignored during research. It means, intervening variables are neither controlled nor taken care of during research. In other words, any moderator variable, that cannot be measured or observed clearly or ignored is called intervening variable.

In our earlier mentioned example of study of value awareness of students, researcher has classified variables like Area, SES, Gender and Value awareness as shown in *Table 1 to 4*. But besides the moderator and controlled variable, mentioned in tables, the following variable can also affect the cause and effect relationship of dependent and independent variables of our example.

- School Environment
- Social environment
- Culture of family
- Value Awareness of Parents
- Extra Reading
- Friend Circle / Peer group of Student
- Emotional Maturity of Students
- Parenting style of parents
- Age of student

These variables are ignored in our example. So, they are called intervening variable for the example that we have discussed till now. There may be more intervening variables for this particular example.

Researcher has to take decision about such variable by consulting experts and by referring and reviewing theoretical literature and reports of earlier related researches.

Actually, variable of study are decided, while deciding the objectives and formulating hypotheses of the study.

We have discussed, in earlier chapters, that the objectives of the research are nothing but the subtitles of the titles. By realising the objectives, based on sub titles one by one, ultimately the main objective of the research is realised. The researcher has to think over the research questions or hypotheses after the objectives of the research. Hypotheses are formulated in most of the quantitative type of researches, but research questions are decided in qualitative type and some quantitative type of researches. Hypotheses or research questions direct the research process. In this chapter, we will discuss about the hypothesis and research question. We start our discussion with the definitions of hypothesis.

DEFINITIONS OF HYPOTHESIS

- It (hypothesis) is a suggested answer to the problem under investigation. – *John T. Townsend*
- A hypothesis is a tentative generalization, the validity of which remains to be tested. – *J. W. Best*
- A hypothesis is a proposition which can be put to test to determine its validity. It may be proved correct or incorrect. – *Good & Hatt*
- A hypothesis is a conjectural statement of the relation between two or more variables. – *F. N. Kerlinger*

MEANING OF HYPOTHESIS

On the basis of the definitions, we can say that hypothesis is an assumption that is still not proved but shows the probable solution of the problem or predicts the relationship between two or more variables. The assumption is proved true or false by testing it. We will not have the solution to the problem until the assumption is tested. Three points, regarding such assumptions, are very important.

**Table – 4
Variables of Study**

Sr.	Variable	Type	Level
1	Area	Independent	1. Urban 2. Rural 3. Semi Urban
2	Socio –Economic Status	Controlled	1. Higher
3	Gender	Controlled	1. Male
4	Value Awareness	Dependent	--

- The assumptions are made on the basis of previous experiences or primary evidences or by thinking logically.
- Whether the assumptions are true or false is decided by testing them.
- Testing of assumptions lead to the solution of the problem.

The assumption, which is made by keeping in mind the above mentioned points in terms of the probable solution to the problem is called hypothesis.

By testing the hypothesis, some fact is established or some theory, rule or principle is formed or generalisation is done in the context of solution of the problem.

Hence, hypothetical statement is not an established fact or principle but by testing it the fact is derived or the solution is generalised. On the other side, the hypothesis is a result of matured and logical thinking process.

To understand the meaning of hypothesis more clearly we will take the example form our practical life.

Suppose we are watching some television programme and suddenly the TV gets off. What will be our reactions to this problem? We start thinking of the reasons of the problem like

- perhaps there is an interruption in the flow of electricity or
- there may be a problem in particular channel or
- there may be a loose connection of the cable with TV or
- there may be a problem in the system of cable operator.

We will make such assumptions on the basis of our previous experiences. Now we will check all the possible reasons of the problem. For that, first, we will check if there is any problem in the flow of electricity.

- If electric supply is found okay, we will check if other channels are working or not.
- If other channels are found okay, we will check whether the cable connection is proper or not.
- If everything is found okay, then we will call cable operator to solve the problem.

In this way, we will collect the evidence and analyse it logically. By testing all the evidences, we come to the conclusion about the solution of the problem. We make many assumptions in our routine life to find the solution to our daily problems.

In the same way, hypotheses are formulated in research, which are tested to come to the certain conclusion in terms of the objectives of the research. But there are some specific structures to be followed to formulate the hypothesis. Some assumption is made in each research hypothesis in terms of the relationship between two or more variables.

Let's take an example of research to understand the formulation of research hypothesis.

Suppose we want to study the social adjustment of the government and non-government employees, then general hypothesis may be as follows:

- Social adjustment of non-government employees is better than that of government employees. **or**
- Social adjustment of government employees is better than that of non-government employees. **or**
- Non-government and government employees are the same as far as their social adjustment is concerned.

In this example, assumption is made in terms of two variables (i) Type of the Employer - Organisation and (ii) Social Adjustment of the employees. The researcher has to collect data and test the hypothesis to come to the conclusion in relation to these two variables.

As discussed earlier, hypothesis is not formulated by imagining baselessly, but it is a result of matured, rational and logical thinking. Such thinking, findings of previous researches and experience of the researcher provide the base for formulating a good hypothesis.

CHARACTERISTICS OF A GOOD HYPOTHESIS

The characteristics of a good hypothesis are as follows:

- A good hypothesis never opposes the universal truth and natural law and rules.
- It is written in simple and easy language.
- Only one assumption is made in one hypothesis.

- The hypothesis is written in such a language that, after testing, it can be clearly rejected or not rejected.
- Hypothesis is written in present tense because it is not a prediction or opinion but it is an assumption that is based on present factual information.
- A good hypothesis assures that the tool required for testing it (hypo) is available or can be prepared (developed) easily.
- Before formulating the hypothesis, it is assured that the data will be available for testing it.
- A good hypothesis assures that the entire process related to data collection and analysis and testing the hypothesis is under the control of the researcher.
- It can be tested with the help of evidences and data.
- If a testing of hypothesis gives a solution of main problem of research, it will be considered as a good hypothesis.
- A good hypothesis gives the clear idea about the area of research, variable and statistical technique to be used for data analysis.
- Generally, a hypothesis shows the relationship between two or more variables.
- Hypothesis is formulated before collecting and analysing the data.
- Hypothesis is formulated by thinking logically.
- Hypothesis is formulated on the basis of available primary evidences.
- If experimental research is there, a hypothesis is formulated before conducting experiment.
- A good hypothesis promotes deductive reasoning.

A researcher should formulate the hypotheses by keeping in mind the characteristics of good hypothesis. For that he should refer the sources of hypothesis.

SOURCES / BASIS OF HYPOTHESIS

The main sources of hypothesis are as follows:

Research Related Theoretical Literature

One can understand the conditions of good hypothesis by referring the theoretical literature of research and books. It helps in planning the entire research process scientifically. Therefore, the researcher should study such literature before formulating hypotheses. But while selecting such literature the researcher should check its reliability and he should refer more than one book to understand any aspect of research.

Report of Earlier Researches

The researcher should refer some reports of earlier researches, which are related with his research problem. Such reports give some idea for formulating good hypotheses. But researcher should not follow the hypotheses given in such reports blindly, instead he should think logically over the hypotheses in the context of objectives, research tool, variables and data analysis techniques adopted by earlier researchers. On the basis of this thinking, he should give base to his own hypotheses.

Pre-Experiences

Sometimes pre-experiences make the researcher select a research problem. His pre-experiences in the field of research area lead him to think over the problem and research process in the right direction. This thinking gives him idea about the probable solutions of the problem. Such ideas help him in formulating good hypotheses and to make his research work unbiased.

Beliefs Prevailing in Selected Field

Sometimes it is found that some strong beliefs prevail in the area, selected for research. People working in that area blindly follow such beliefs. These beliefs provide base for formulating hypotheses, when researcher attempts to do research to challenge such beliefs.

Culture

Culture of any country influences its social, economic, technical, industrial, political and educational development. It motivates the person to develop its working system in a certain way. Culture establishes some morals and traditions in the society and directs the thinking process of the people. When the researcher attempts to study about the factors, which are influenced by the culture, the culture provides base for formulating hypotheses.

Intellectual Discussion with Subject Experts

If the researcher does not have enough information regarding the field that he has selected for research or he does not have experience in that field, he should contact the persons and experts associated with the field and discuss various aspects of that field. Such discussion guides the researcher to formulate the hypotheses.

Creative Thinking

Creative thinking inspires the person to be involved in creative work or to do something new. Creative thinking makes the person think over the same matter in different ways. Therefore, if a researcher does not have enough idea about the field, he should apply his creative thinking ability to formulate the hypotheses.

Insight of the Researcher

The continuous thinking, over the research problem and the area of research, can develop the insight of the researcher. This insight helps him in formulating good hypotheses.

Inventions done in the Field of Science and Technology

Inventions done in the field of science and technology introduce new techniques and technology. Use of new technology in brings remarkable changes in the working system of any field. Such system provides new ideas for the formulation of hypotheses. On the other side, computer and information technology has made the analysis of a large data easier than before. So, the researcher can include large population and sample in the research. Moreover, digital camera, web camera, social networking system, e-mail, audio conferencing and video conferencing help in collecting large data. It provides the opportunity of including more variables in the hypotheses. In this way, the inventions of science and technology widens the scope of including more hypotheses in one research.

Analogy

Many rules, principles and theories, related with behaviour science, psychology and education, are established or developed by conducting experiments on the animals. Such experiments provide base for formulating hypotheses in educational, psychological and sociological researches. Formulating hypotheses for the research in one field on the basis of the theories and principles established in other field is called analogy.

Some sources for formulating hypotheses are given here. It is not a final list of the same. In future, technological development may introduce more sources.

One can formulate good hypotheses only if he has a knowledge of the types of hypotheses.

TYPES OF HYPOTHESIS

It is very difficult to give such a classification of hypotheses as can be accepted universally because different scholars have classified the hypotheses in different ways. On the basis of different classifications, the types of hypotheses can be described as follows.

Declarative Hypothesis

If a researcher formulates the hypothesis by keeping in mind some expected result, it is called declarative hypothesis. This is known as alternate or research hypothesis also. Researcher expects some result on the basis of his experience in the field or on the basis of the review or study of the literature. He converts such expectation in the hypothesis. It means, he makes some declaration about the result of the research. That is why such hypothesis is called declarative hypothesis.

Declarative hypotheses are denoted by $H_1, H_2, H_3, \dots, H_n$

Some Special features of declarative hypotheses are as follows:

- Researcher formulates the declarative hypotheses on the basis of pre-experience, study of research material or on the basis of the findings of previous researches.
- Such hypotheses are formulated on the basis of expected findings of the research.
- Such hypothesis is accepted when null hypothesis is rejected.
- Such hypothesis is influenced by the beliefs of the researcher. Therefore it cannot remain unbiased always.
- There are two types of declarative hypothesis. 1. Directional and 2. Non-directional.

Directional Hypothesis. This hypothesis shows the expected direction of results. It means such

hypothesis assumes a particular result in favour of some factor / variable. In other words it can be said that directional hypothesis expects particular result in favour of a certain variable out of the probable results.

Directional hypothesis indicates clearly the difference or relationship between variable characteristics under study in the context of independent variable.

E.g. the following directional hypotheses can be formulated in the context of the title ‘Study of the teaching aptitude of student-teachers in the context of their gender.’

- The teaching aptitude of the male student-teachers is better than that of female student- teachers. *OR*
- The teaching aptitude of the female student-teachers is better than that of male student-teachers.

In both the hypothesis teaching aptitude of one is expected better than others. In this way, both hypotheses show certain result of the research in favour of certain variable. Here, teaching aptitude is a variable characteristic under study and gender is an independent variable.

The following directional hypothesis may be there in the context of the title ‘Study of the relationship between emotional maturity and adjustment level of female teachers of secondary schools.’

- There is a positive correlation between emotional maturity level and adjustment level of the female teachers of secondary schools. *OR*
- The adjustment level of female teachers of secondary schools having high emotional level is high.

Here, both hypotheses show positive relationship between emotional maturity and adjustment level of female teachers. It means, both indicate a certain direction of the finding. For the same title, hypotheses may be written in the following way also.

- There is a negative correlation between emotional maturity level and adjustment level of the female teachers of secondary schools. *OR*
- The adjustment level of female teachers of secondary schools having low emotional maturity level is high.

Above mentioned hypotheses clarify that directional hypotheses expect certain type of relationship between two or more variables.

If the researcher cannot remain unbiased with the process of research, such hypotheses may lead him to formulate the hypotheses on the basis of his own beliefs instead of taking the pre experiences and available primary evidences into consideration. His such act may bring subjectivity in formulation of hypotheses, which will make the researcher collect only such data that can support his beliefs.

Non-directional Hypothesis. The hypothesis, which does not indicate the direction of the result or in which the result is not expected in favour of certain variable is called non-directional hypothesis. More clearly, it can be said that it assumes the difference but does not favour any variable in terms of dependent variable. In inter-relational studies, it assumes the relationship between variables but does not clarify the type of relationship like positive or negative.

Suppose a research is to be carried out to study the teaching competency of higher secondary teachers in the context of their gender, non-directional hypothesis will be as follows:

- There is difference between teaching competency of male and female teachers of higher secondary schools.

This hypothesis assumes difference between the teaching competency of male and female teachers but it does not favour any of them (male or female). It means, it does not expect the result in any one direction. According to this hypothesis the finding of the research may be in favour of male or female.

We take another example of this type of hypothesis in terms of relationship between two variables.

Suppose a research is to be carried out to study the relationship between emotional maturity and mental health of secondary school teachers, then non-directional hypothesis will be as follows:

- There is a correlation between emotional maturity and mental health of secondary school teachers.

This hypothesis expects relationship between two variables but does not assume the type of relationship like positive or negative.

Hypothesis in Question Form

In this type of hypothesis, instead of expecting a certain result, a questions is formed asking whether

certain type of result will be there or not.

E.g. in the context of the research title ‘study of exam anxiety of higher secondary schools’ students in the context of their stream’ the question type hypothesis will be as follows:

- Is there difference between exam anxiety of arts, commerce and science students of higher secondary schools? *OR*
- Is the exam anxiety of arts students of higher secondary schools more than that of science students? *OR*
- Is the exam anxiety of commerce students of higher secondary schools more than that of science students? *OR*
- Is the exam anxiety of commerce students of higher secondary schools more than that of arts students? *OR*

Let’s take another example to understand such type of hypothesis in terms of the relationship.

If the study is to be carried out to know the relationship between intelligence and mental stress of government employees, the question type research hypothesis will be as follows:

- Do the government employees having high intelligence level have less mental stress? *OR*
- Do the government employees having low intelligence level have more mental stress? *OR*
- Is there positive correlation between intelligence and mental stress of government employees? *OR*
- Is there negative correlation between intelligence and mental stress of government employees? *OR*
- Is there correlation between intelligence and mental stress of government employees?

Referring to the above mentioned hypotheses, it is quite clear that the question type hypothesis may be declarative or non-declarative.

Null Hypothesis

If, in the context of dependent variable, the hypothesis indicates ‘no difference’ between two or more levels of independent variable, it is called null hypothesis. Null hypothesis indicates no relationship between two variables, if correlational study is there. Null hypothesis is indicated by the symbol H_0 . Such hypothesis is also called ‘no difference’ type of hypothesis or ‘no relation’ type of hypothesis.

Let’s take examples to understand this type of hypothesis.

For the study of the impact of instructional method on the achievement of the students of grade nine in English, the null hypotheses will be as follows:

- There is no significant effect of instructional method on the achievement of the students of grade nine in English. *OR*
- There is no significant difference between achievement of the students in English, who have learnt through Computer Assisted Instruction (CAI) and Programmed Learning Material (PLM). *OR*
- There is no significant effect of instructional method on the mean achievement scores of the students of grade nine in English. *OR*
- There is no significant difference between mean achievement scores of the students of grade nine in English, who have learnt through CAI and PLM.

(Note : - In the example discussed above, certain instructional method is not mentioned in the title of the study, but two methods are mentioned in hypotheses. If the methods are mentioned in the title of the study, they can be mentioned in this way in the hypothesis. Researcher may indicate the instructional methods in title of the study also, but while doing so, the title will be lengthened.)

Let’s take an example to understand null hypotheses in the context of relationship between two variables.

If a researcher wants to carry a research on ‘Study between the mental health and reasoning ability of the students of secondary school’, the null hypotheses will be as follows:

- There is no significant relationship between mental health and reasoning ability of the students of secondary schools. *OR*
- There is no significant correlation between the scores of the students of secondary schools in mental health scale and reasoning ability test.

We have discussed different ways of writing null hypotheses. Null hypotheses can be classified in two different ways on the basis of description of measurement in it (in hypotheses).

TYPES OF HYPOTHESIS ON THE BASIS OF DESCRIPTION OF MEASUREMENT

Two types of hypotheses on the basis of description of the measurement are as follows:

Classical Hypothesis

If the measurement is not mentioned in null hypothesis, it is called classical null hypothesis.

E.g.

- There is no significant difference between the achievement of the students of grade nine in English, who have learnt through Programmed Instructional Material (PIM) and Computer Assisted Instruction (CAI).
- There is no significant relationship between mental health and reasoning ability of the students of secondary schools of Gonda city.

Any kind of indication about the measurement is not there in both hypotheses.

Operational Hypothesis

When the measurement of the variable characteristics is indicated in null hypothesis, it is called operational hypothesis.

E.g.

- There is no significant difference between mean scores of the students of grade nine in achievement test in English who have learnt through Programmed Instructional Material (PIM) and Computer Assisted Instruction (CAI).
- There is no significant correlation between the scores of the students of secondary schools of Gonda city in reasoning ability test and mental health scale.

In the first hypothesis, scores of the students in achievement test is mentioned and for testing this hypothesis, means of achievement scores of both groups have to be calculated. Mean is a measurement in this hypothesis.

In the second hypothesis, correlation between the scores of the students in mental health scale and reasoning ability test is mentioned. Therefore, coefficient of correlation has to be calculated to test the hypothesis. In this way, the term 'correlation' indicates the measurement in this hypothesis.

Operational null hypothesis can be made more accurate by indicating the name of the specific tool of the research in it.

- There is no significant difference between mean scores of the teachers of government and self-financed secondary schools of Rohtak city in teaching aptitude test developed by Satishprakash Shukla.
- There is no significant correlation between the scores of the students of secondary schools of Gorakhpur city in reasoning ability test developed by Dushyant Shukla and mental health scale developed by Rita Shukla.

SPECIAL FEATURES OF NULL HYPOTHESIS

Researchers prefer to formulate null hypotheses due to their some special features. These features are as follows:

- It is formulated objectively and not affected by the subjectivity of the researcher.
- It believes in 'no difference' or 'no relationship'. So the researcher does not tend to be biased for certain type of the result and works freely.
- It helps in making the entire research process objective (unbiased).
- It challenges the research (Alternative) hypothesis but does not recognise it.
- It is tested at certain level of significance.
- If the findings of the research oppose null hypothesis, it is rejected and research hypothesis is not rejected.
- If the findings of the research do not oppose null hypothesis, it is not rejected and research hypothesis is rejected.
- It can be tested clearly by applying appropriate statistical techniques.
- Variables are mentioned clearly in null hypothesis.
- It indicates clearly the statistical technique to be used for testing it in most of the cases.

- Which research tool is to be used is also clarified in most of the null hypothesis. After understanding the meaning and types of hypothesis, let's understand its importance.

UTILITY / IMPORTANCE OF HYPOTHESIS

- It assumes the result of the research. Researcher collects data to test this assumption.
- It specifies the type of data to be collected and prevents the researcher from collecting unnecessary data.
- It helps the researcher to work in certain direction.
- It helps in deriving clear findings of the research.
- It gives the idea about the area and variables of the study and statistical technique to be applied for data analysis.
- It gives the idea about the structure of writing the findings in research report.
- It inspires the researcher to do deductive reasoning. (In common term we can say that the thinking that is done to search the evidences to prove the established theory, principle or rule is called deductive reasoning.)

In many hypotheses that we have discussed till now, the phrase 'significant difference' is used. Here a question arises, is there any difference between 'difference' and 'significant difference'. Let's us understand it.

STEPS OF RESEARCH PROCESS

Research is a well-planned and objective oriented process that is carried by following the logical steps. Different scholars have suggested different numbers of steps of research process according to their own perception, experience and the nature of the research. Another reason of the difference in number of steps is some scholars have divided some steps in sub steps and some have merged different steps in one step. By referring the steps given by different scholars, general steps of research process can be given as follows:

Identifying the Area of Research

This is the first and the most important step of any kind of research process. Till now, it is quite clear that research is a process in which researcher attempts to find the solution of certain problem. For that, he must have good knowledge of the field in which the research is to be carried out. If we think minutely, we can find some problems in all the areas concerned with living being and nature. Every person may not have the same level of knowledge about all the aspects of the field, he has been engaged with. So, before starting the thinking over conducting a research, a researcher must select such an area in which he finds himself comfortable.

Suppose a researcher, who wants to conduct a research in the field of education, will find various problems in different areas, related with education, like teaching learning process, educational technology, syllabi of different classes, structure of education system, primary – secondary – higher secondary – higher education, schools, educational psychology, admission system, evaluation or examination system, teachers, teacher training, parents, students, educational policies, agencies working in the field of education etc.

So, the researcher must select such a problem for research for which he can work efficiently.

This step of research process is very much important for the students also, who are conducting research for obtaining a degree. Because, most of them, do not have any previous knowledge about the research and they have to complete their research within a certain time period. So, before proceeding for research, they must introspect themselves in terms of their interest, abilities and skills. They should select such an area of research as they are comfortable with.

Review of Related Literature

After selecting the area of research, the most important thing is to understand the functioning of the area or the factors associated with that area. For that, the researcher has to study the theoretical literature related with that area. Such a study gives him in depth idea about the rules and regulations prevailing in that area, factors affecting the functioning of the area, persons working in that area, future requisites, strength and weaknesses, supporting system of that area and trends prevailing in the area. In short, by referring theoretical literature, researcher tries to understand entire system of the area of research.

Besides theoretical literature, at this stage, previous researches conducted in selected area are also studied. It helps researcher to know the trend of the researches in the area, problems covered for researches, research tools available, types of research carried out, variables, factors, population covered by previous researches and findings of various researches.

Selection of Problem

The third step of research process is to select a research problem. At this moment, the researcher selects a problem by keeping in mind the possibility of research in the selected area, priorities in the that area, available resources for research, time limit, expense, his own abilities and availability of other supporting services. Then he selects and defines the problem and state the problem in proper statement. He also defines the terms used in the statement of the problem.

Study of Reference Material

At this stage of research, the literature, which clarifies different concepts related to research and explains different aspects of research, are studied deeply and reviewed. On the basis of which, researcher tends to find the answers of the following questions.

- Which code of conduct is to be followed during research?
- What will be the type of research?
- What will be the objectives of research?
- Will there be hypotheses or research questions?
- What care will be taken for formulation of hypotheses or constructing research questions?
- Will there be variables or not? If yes? Which and why?
- Which research tool will be required for research?
- Whether tool will be developed or readymade tool will be taken?
- If it is to be developed, which process is to be carried out?
- How to get a tool, if it is decided to use readymade tool?
- Which points should be kept in mind, while using a readymade tool?
- Which research method will be followed?
- What will be the population of research?
- Whether the sample is to be selected or not?
- If yes, which sampling method will be applied?
- Are the subjects to be given any treatment?
- If it is to be given, then for how much time and how?
- What will be the procedure for collecting data?
- Will the assistants be required for collecting data?
- If yes, how to manage them?
- How the data will be classified?
- How the data will be analysed?
- Which statistical method, if required, will be used for analysis of data?
- How much time the entire process of research will take?
- Which additional material of devices will be required? How they will be managed?
- How much expense is expected for entire process?

Research based reference material and previous research reports are studied and reviewed for answering the above mentioned questions. The way of performing various research activities adopted by previous researchers and their efforts for justifying such activities and the actions taken by them to solve the problems, can be understood by reviewing previous research reports. By reviewing such literature, researcher plans and performs research activities. However, the study of research related literature continues from selection of the problem till the research report is written, printed and submitted to the authority.

Clarifying the Objectives of Research

Research is an objective oriented process. Therefore its objectives must be clear and precise. Objectives clarify the path of research process. Objectives are nothing but subtitles of research title. They

divide the main research question, indicated in research problem, in sub-questions. Therefore, the more precise the research problem is, the more precise the objectives will be. At this stage of the process, research objectives are finalised. It needs so much care and precision, because hypotheses, if any are there, are formulated on the basis of objectives.

Formulation of Research Questions or Hypotheses

If variables are indicated in the objectives of research, hypotheses are formulated in most of the cases at this stage. Findings of the research are directly associated with hypotheses. It means, findings are derived by keeping in mind the hypotheses.

If interrelationship among the variables is not to check by the research, research questions, are formed instead of hypotheses. Moreover in most of the qualitative researches, research questions are formed at this stage.

Some scholars are of the view that if objectives are mentioned precisely and hypotheses are not to be formulated, remaining process of research should be carried out on the basis of objectives. In such cases research questions should not be formed. But, still, there is a tradition, of forming research questions in some institutions, if hypotheses are not to be formulated. Researcher should follow the guide lines, if any, given by the funding agency or the institute to which the research report is to be submitted, or else, follow the tradition prevailing in his field.

Remember, if hypotheses are formulated, each of them must be based on any of the objectives. Only one assumption should be there in one hypothesis and it must be formulated in such a language that after testing, it can be clearly rejected or not rejected.

Clarification of Variables

Hypotheses or research questions give indication about the variables of study. So at this stage, researcher analyses the hypotheses and research questions with a view to finalising the variables of study. Moreover, at this stage, different types of variables, involved in the study are defined and clarified with the reasons of categorising them in different types.

If variables are not involved in research, this stage of process is ignored. Variables are not given importance in most of such researches, which are conducted by applying research methods like Case Study and Content Analysis. Moreover, variables are not considered in most of the qualitative researches. But we can't say that variables should not be there in such researches. It all depends upon the objectives of study. So at this stage also the researcher must be very careful, especially when he tends to avoid the inclusion of variables in research.

Researcher should think over all the five types of the variables at this stage and should clarify all of them in terms of his research. Five types of variables are (a) Independent, (b) Dependent, (c) Moderator, (d) Intervening and (e) Controlled variables.

Clarification of Research Method

Actually the type of research is decided at the time of finalising the research problem, but at this stage, the type of research is clarified with logical argument. As discussed earlier, there are three types of research and they are Basic Research, Applied Research and Action Research.

Besides the clarification of type of research, researcher selects an appropriate research method in order to realise all the objectives in proper way. The main research methods are Descriptive, Experimental and Historical.

Selection or Development of Research Tool

This is also an important stage of research process, because remaining stages depend on research tool. Actually, research tool is decided with the formation of research questions and / or formulation of hypotheses. Any technique, device or any written or printed material, through which the data are collected is known as research tool. Some of the research tools are Observation Sheet, Achievement Test, Diagnostic Test, Questionnaire, Schedule, Inventory, Interview, Rating Scale, Check List, Sociometry, Sociogram, Opinionnaire, Attitude Scale, Aptitude Test and Self – Evaluation Sheet. Researcher selects a tool according to his requirement. In most of the cases, researcher himself develops a tool for his research. But, if any such tool is available in the area of research that can fulfil all requirements of expected tool, researcher should use it. In this way he can save his time, energy and money.

Determining Population and Sample Selection

Such a set of the units on whom the findings of research are to be generalised is called population. All the units of population possess the variable characteristics under study. At this stage, researcher defines his population clearly and decides whether the sample is to be selected or not. If yes, he decides the size of sample and sampling method to be applied for selecting a sample. Then he selects a sample. If he decides to collect data from all the units of population, he does not need to think about the sample.

Data Collection

After selecting a sample, researcher collects data by using the research tool. He makes a plan for data collection, in which he clarifies how, when, at which time, from whom and by whom the data will be collected. If he is doing experimental research, he gives the necessary treatment to the subjects of research before collecting data. Sometimes data are collected both before and after the treatment. If required, he collects data at both time. Sometimes experiment is conducted two or more times in experimental researches and data are collected after each experiment.

If large sample is selected, then researcher takes help of research assistants for collecting data.

Data Analysis and Interpretation

After collection of data, they are classified and tabulised in order to analyse them. Pre-determined technique of data analysis is applied and its results are interpreted at this stage. Here, hypotheses are tested or efforts are made to find the answers of research questions. If necessary, data and results are presented in pictorial, graphical form or in figure.

Writing and Dissemination of Report

At the end of research process, findings of research are derived on the basis of the interpretation of the results obtained by analysis of data and interpretation. Findings of research also are discussed in the context of findings of previous researches.

Then research report is prepared, in which the entire research process is discussed clearly but briefly in the way that it can be understood easily by the readers. Special care is taken to write the findings in the simplest language as possible so that any lay man, who has nothing to do with research the research process can also understands it in right contexts.

At last the report is made public through the institute to which it is submitted. If the information regarding the research is to be kept secret, report is not made public.

Generally, the steps of research, discussed above are followed in researches related to education, psychology, sociology and humanities. However, researcher is free to make any change in the sequence of the steps, if required, or he can add more steps in the process.

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