Chapter 3:
Research Methodology

Any research study requires a systematic collection of data from the selected sample through the use of appropriate data gathering devices. Educational research has three-fold objectives i.e., *theoretical, factual and application*. These objectives will be achieved only by employing different methods and strategies of research. Method is only the abstract, logical entity that one can distinguish between matter and method. In reality, they form an organic whole and matter determines method, analogously as objectives determines, means and context and spirit determine, styles and form in literature. A pre-planned and well described method will provide the researcher a scientific and feasible plan for attending and solving the problem under investigation.

Here, the researcher intended to discuss the methodological considerations used in this research study. This will enable the researcher to proceed scientifically in the conduct of the research such an exercise will result in arriving at valid and meaningful conclusions. Any implications drawn on such conclusions will be helpful to the planners and practitioners in education.

3.1 Hypotheses of the Study

The following null hypothesis was formulated by the researcher.

Null Hypothesis

The null hypotheses are very important in the research because the null hypotheses provide an approximate description of the phenomena and we can have relational statement. And we can test the association between the variables based on rejection or acceptance of the null hypotheses. Basically, in inferential statistics, the null hypothesis is a general statement or default

position that there is no relationship between two measured phenomena, or no association among variables.

The researcher will formulate the following null hypotheses at the 0.05 level of significance.

H_{O1}- There is no significant effect of the intervention/treatment given to alleviate errors committed by students in integer

3.2 Design of the Study

Keeping in view the number of variables to be studied in the present study and their relationship and the linkages between different variables the Mixed Method Research Design (Exploratory Design) comprising elements of Quantitative and Qualitative data was used for the present study. For the purpose of Quantitative Data, Single Group Experimental Design is used whereas for the purpose of Qualitative Data, Phenomenology approach is used.

Stage-I: With the aim of understanding and identification of errors committed by learners most often a '*structured pre-test*' was designed comprising of 5 types of questions having different difficulty level with comprehensive sub-parts (Levels of Bloom Taxonomy will be taken into considerations) in accordance with the *Blueprint* designed. And the questions were selected randomly from the NCERT prescribed elementary mathematics textbooks comprising of problems related to Integers.

And, with the aim of taking perspective on Integers of mathematics teachers a structured questionnaire was prepared for qualitative analysis.

Stage-II: The responses were collected back by the students as well as teachers and were analysed critically to give requisite treatment and obtain the desired outcome. For this purpose, an interactive lesson

plan was designed following the *'Constructivist Approach'* i.e., the *'5E-Model'*. And this lesson plan was administered to the students.

Stage-III: After the comprehensive treatment and interventions to test the level of achievement the *'structured post-test'* was designed on the similar fashion or manner as that of *'structured pre-test'* and achievement was measured. The scores were quantified, and inferences based on it were made.

3.3 Research Instrument

The Research Instrument is a *'tool'* defined as "*Anything that becomes a means of collecting information for your study is called a research tool or a research instrument. For example, observation forms, interview schedules, questionnaires, and interview guides are all classified as research tools.*"

The researcher made tool was employed for the purpose of drawing necessary conclusions.

3.3.1 Need for the Tool/ Justification of tool

It is necessary to adopt a systematic procedure to collect essential data for research. Relevant data, adequate in quantity and quality **should** be collected for the purpose of research to draw meaningful conclusions. The instruments thus employed as means for collecting data are called **tools**. The selection of suitable instruments or **tools** is of vital importance for successful **research**. The tools used may be standardised, but sometimes certain variables are studied such that a tool needs to be developed i.e., Researcher himself prepares the tool. Here, in this study since we had to find out common errors committed by students which are *'context-specific'*. Hence, researcher made tool was incorporated for the collection of data.

3.3.2 Development of Tool

There are several tools available for the purpose of measurement but for the current problem there was no ready-made tool was available hence, the tool was developed by the researcher to collect requisite data following rigorous procedure of tool development. This process involved two phases namely *'Initial Phase' & 'Final Phase'*.

3.3.2.1 Initial Phase

It involved the below mentioned steps-

Section-A

It contains the details of the tool used for Single Group Experimental Design i.e., the development of *pre-test* and *post-test* for the collection of quantitative data.

a) **Personal Data Sheet**

A personal data sheet was attached for the purpose of collecting various details of respondents i.e., Name, Name of the school, Gender, Medium of Instructions, Alternative Classes, Community to which a respondent belongs. The personal data sheet field was not kept mandatory to achieve maximum responses.

b) **Tool Description**

A detailed *'blueprint'* was prepared to give clear weightages to different types of questions as per the Cognitive Domain of Bloom Taxonomy. The details of it are as below: -

- **Weightage as per the objectives of Bloom Taxonomy:**

S.No.	Objective	Marks	Percentage
1.	Knowledge	8	26.67 %
2.	Understanding	8	26.67 %
3.	Application	10	33.33 %
4.	Skill	4	13.33 %
	Total	30	100 %

Table 3.1- Weightage as per the objectives

- **Weightage given to different types of questions:**

S.No.	Form of question	Marks	Percentage
1	MCQ	5	16.67 %
2.	True/False	5	16.67 %
3.	List Matching	6	20 %
4.	Graph Plotting	4	13.33 %
5.	Word Problems	10	33.33
	Total	30	100 %

Table 3.2- Weightage as per the Ques. types

- **Weightage as per the selection content:**

S.No.	Content	Marks	Percentage
1.	Integers	30	100 %
	Total	30	100 %

Table 3.3- Weightage as per the content

c) Area of the Tool

Since, the aim of the current research was to identify the common errors committed in Integers. Hence, questions posed in the tool were strictly oriented towards problems on *'Integers'*. The questions were picked from the NCERT prescribed textbooks on mathematics of elementary stage. The questions on Integers involved various operations of mathematics and associated properties of Integers.

d) Item Description

The items in the tool included objective as well as subjective areas of question for the assessment of students and find out errors. Questions were based on the factual knowledge of integers, understanding of integers as well as questions on ability to apply those facts in multiple situations like word problems were also included.

MCQs, T&F and Matching-

1) They were used to limit the scoring bias due to its objective nature.
2) They are easy to administer and score.
3) It allows to assess wide range of learning objectives.
4) Best suited to students having low-level of reading.

On the other hand, they have some disadvantages also like-

1) Development of good items were time consuming.
2) Measuring ability to organise and express ideas is not possible.
3) T&F encourages guessing as compared to MCQs and Matching.

Number Line-

The main objective of number line was to assess whether the students were able to identify and spot the number accurately or not. It provides idea on understanding level of students.

Word-Problems-

The word problems were incorporated to assess and measure the ability of students to apply his knowledge and understanding, rather than just retention of information and being able to call it verbatim. Although, biasness in scoring cannot be denied while evaluating these types of questions. Also, they seem to be difficult for students having lower level of reading and comprehension.

Section-B

It contains the details of the tool used for Phenomenological Design i.e., the development of *structured questionnaire* for the collection of qualitative data. It was meant for to analyse the perspective of mathematics-teachers on Integers. As the teachers are key resource person of knowledge who teaches

in the classroom. It is his efforts on which the learning of students depends.

a) Personal Data Sheet

A personal data sheet was attached for the purpose of collecting various details of respondent teachers i.e., Name, Professional Degree, School they teach, Gender, Medium of Instructions they provide. The personal data sheet field was not kept mandatory to achieve maximum responses.

b) Tool Description

The major objective of this tool was to understand the process how a teacher perceives problems of Integers in mathematics and his/her ability to provide concrete or abstract idea about the topic i.e., Integers. It is reported that many teachers involve in rote teaching without justifying the facts and properties related to topic hence the questions were kept totally subjective covering various aspects of Integers to analyse their generalisation and logical reasoning over the question posed. The total number of subjective questions were 8 in number.

c) Area of the Tool

The subjective questions covered here were from the topic Integers which were aimed at analysis of the esoteric or abstruse ideas of the Integers.

d) Item Description

Each question had a statement covering the various properties of integers followed by a subsequent question to reason why it is?

The questions were based on the idea of zero and its properties, the property of additive and multiplicative inverse, idea of number-line and equidistant points on number line, idea on properties of product and difference of integers, and rules of division and multiplication.

3.3.2.2 Final Phase

It involved the below mentioned steps: -

Section-A

It contains the details of finalisation of quantitative test: -

a) **Name of the Tool**

The tool incorporated for the collection of Quantitative Data was entitled as *"The Mental Ability Test of Students in Integers in Mathematics"* also known as *'MAT-SIM'*. Since, the tool was aimed at collecting the responses of students on various aspects of Integers.

b) **Standardisation of Tool**

Tool is the vital instrument for the collection of data and investigation of problem; hence it includes the different components involved in study. The research tool MAT-SIM was aimed at collecting responses of various students to identify common errors committed by them; hence, it contained context specific word problems and components to test and analyse the

factual properties of integers and its application. For the purpose of standardisation of constructed tool, it was sent to professional experts to get their comments and make the tool more professional and administrable. The tool was constructed in English and Hindi so help from language expert who was well versed on languages was taken.

- **Validity of the Tool**

  In the process of standardisation of tool, the validity of the tool is also confirmed for best outcomes. Validity tells us about the accuracy by which tool measures something i.e., Variables.

  Construct Validity-Construct validity evaluates whether a measurement tool really represents the thing we are interested in measuring. It is central to establishing the overall validity of a method. And for this purpose, expert advise was sought from Dr. Saurabh Kumar, Assistant Professor, RIE, Bhopal and Dr. Prateek Chaurasia, Assistant Professor, Mizoram University.

  Content Validity- Content validity assesses whether a test is representative of all aspects of the construct. Since, test was related to mathematics the expert advise was taken from Dr. Prateek Chaurasia, Assistant Professor, Mizoram University and Mr. Sunil Kumar

Sharma, Senior Lecturer Mathematics, Sri Ratan Shukla Govt. Inter College, Kanpur

Face Validity

Face validity considers how suitable the content of a test seems to be on the surface. It's similar to content validity, but face validity is a more informal and subjective assessment. The advice on this was taken from previous experts as well as for the linguistic analysis advise was sought from Dr. Ganga Mahto, Asst. Professor (English), RIE, Bhopal and Dr. Arunabh Saurabh, Asst. Professor (Hindi), RIE, Bhopal.

Criterion Validity

It was difficult to evaluate due to absence of other tests of similar types.

Section-B

It contains the details of finalisation of qualitative test: -

a) **Name of the Tool**

The tool incorporated for the collection of Qualitative Data was entitled as *"The Perception and Understanding of Mathematics Teachers on Integers"* also known as *'PU-MTI'*. As, the tool was aimed at collecting the responses of mathematics on various aspects of Integers related to abstruse domains of Integers.

b) **Standardisation of tool**

The research tool PU-MTI was aimed to get responses from mathematics teachers teaching at school since

the test was subjective and in the form of questionnaire. For this purpose, expert advice was sought from Dr. Prashant Kumar Astalin, Asst. Professor of Psychology and Education, University of Allahabad, Dr. Brajesh Kumar Sharma, Asst. Professor of Algebra and Number Theory, University of Allahabad and Mr. Sunil Kumar Sharma, Senior Lecturer Mathematics, Sri Ratan Shukl Govt. Inter College, Kanpur.

3.3.2.3 Administration of Tool

a) Administration in the class- The tool was printed on the sheet of paper to collect responses from the students. Permission of the head of the school was taken duly to collect responses. And they were assured that it was only for the research purpose and the data collected will not be used against them in any form. The students were explained about the purpose of test to avoid any misconceptions and make it easy for the students to attempt test.

b) Time of the Test- The time of the test was kept 1hours 30minutes so that students may get ample of time to attempt all questions.

c) Scoring of the Test- A total 30 marks were allotted for the test administered. Which was further subdivided in several items.

d) Analysis of Samples- The test was collected back from the students for assessment and evaluation of

them. Thereafter, marks were awarded as per the scheme of test. Pattern in wrong answers were analysed to draw necessary conclusions.

3.4 Nature of Sample

A sample is a small proportion of population selected for observation and analysis. It is a collection consisting of a part of subset of the objects or the individuals of population which is selected for the exclusive of representing the population. The sampling technique used for the selection of school was *'Simple Random Sampling'* and for the selection of students *'Purposive Sampling* 'was used. Whereas *'Convenience Sampling'* was used to collect responses from the mathematics Teacher.

3.5 Sample of Study

The sample of study comprised of students from 4 schools i.e., two government schools and two self-financed schools. The total no of students who participated in investigation were 112 from all the four schools.

The schools are situated within the vicinity of Mangalpur Kshetra Panchayat of Kanpur Dehat District. The number of mathematics teacher those who participated in study were 14. Sincere efforts were made to take the gender balance into considerations and account to increase the Generalisibility of the study.

3.6 Data Collection Procedure

The researcher had personally visited the schools along with research tools. And after obtaining the permission from the Head of the School, the investigator introduced himself and explained the purpose of the test and questionnaire. The researcher also tried to clarify the doubts

of the students and teachers before the test and questionnaire was employed.

3.7 Statistical Techniques

For the purpose of data analysis, the following statistical techniques would be used-

1. To compare the achievement scores of pre-test and post-test the mean and standard deviation was calculated.
2. To check the significance of treatment and intervention *t-test* was used.
3. The responses of teachers shall be employed qualitatively for that no statistical technique is required.