SWAMI RAMANAND TEERTH MARATHWADA UNIVERSITY, NANDED

Study material for M.P.Ed Students

EXPERIMENTAL RESEARCH

Singh S.K,(SRTM University (Nanded).

The experimental method of research provides a logical systematic way to answer the question, " If this is done under careful, controlled conditions, what will happen ? " . It is considered to be the most authentic method of scientific inquiry. As compared to other research methods, it is more objective, reliable, accurate and precise.

Experimental method is designed to determine causal relations and factors. It determine the cause and effective relationship in real life situations. It is the systematic process associated with testing hypothesis under known conditions whereas many extaneus factors as possible are eliminated, careful and critical observation is affected in a controlled settings or situations and by means of a comparative analysis evidences is sought to be established. An experiment is considered to be the ultimate form of research, design, providing the most rigorous test of hypothesis that is available to scientist.

Experimental research play its role in physical education and sports. It proved to be an effective method as long as controlling of various influencing variable. Randomization, replication and interrelated conditions of experimentation continue to be its basis process.

Types of Experimental research :

There are two types of experimental research. Field experimentation and laboratory experimentation.

(i) Field Experimentation :

It involves the actual manipulation of conditions by the experimentor in order to determine causual relation. In field experimentation conditions on controls are relaxed. In field researches are mainly of observation natural setting until strict controls are imposed.

(ii) Laboratory Research :

It is more precise, controlled and exact. Conditions are created and studied. They are not at all natural but manipulated.

Nature of Research Problems in Physical Education :

Most of the research problems in physical education and sports came from the field i.e. actual dynamic of human behaviour but track, gymnasium, courts, field etc are considered to be real laboratories.

Since physical education is an electric discipline and its activities are of varied in nature similary its research problems are of varied nature. These problems may be experimental or discriptive in nature but without the experimental studies in physical education and sports.

Experimental and Control Groups :

An experiment involves the comparison of effects of a particular treatment with that of a different treatment or at no treatment.

There are two groups usually made to an experimental group and control group. The experimental group is exposed to the influence of the factor under consideration. Observations are then made to determine what difference appearens or what change or modification occurs in the experimental as contrasted with the control group.

Variables :

Variables are the conditions or characteristics that the experimenter manipulates controls, or observes. Generally there are two prevalent variables are as follows.

1. Independent variables :

The independent variables are the conditions or characteristics that the experimenter manipulates or controls in his or her attempt to ascertain their relationship to observed phenomena.

2. Dependent variables :

Dependent variables are the conditions or characteristics that appear or change as the experimenter introduces, remove or changes independent variables.

Experimental Design :

Experimental design is the blueprint of the procedures that enables the researcher to test hypotheses by reaching valid conclusions about relationship between independent and dependent variables.

Selection of an appropriate design for any research study is the most difficult aspect of the research procedures. Specific pattern of research design is required and followed for different kinds of researchers.

There are different kinds of designs which are as under.

1. Randomized Block design :

The most valuable of all experimental designs, the most frequently used and except for the completely randomized, the simplest in construction and statistical analysis is the randomized block design. Randomized block experiment is a term that stems from agricultural research in which several variables, or replication.(The repetition of the treatments under investigation is known as replication) of the experimental effects, such as yields of different types of soya

beans or the quality of difference making of fertilizers. But differences in crop yield may be attributed not only to kinds of soya beans but also to differences in quality of blocks of land. To isolate the " block – effect " randomization-achieved by assigning treatments at random to plots of each block of land is employed. The blocks are formed in such a way that each contains as many plots as there are treatments to be tested and one plot from each is randomly selected for each treatment. The scheme is most readily understood by visualizing a field plan for an a agricultural experiment, say for four treatment (A, B, C, D) in six Experimental Design blocks of four plots. The arrangement on the field might be as shown below.

I		II		III	
A	D	B	C	C	A
C	B	A	D	D	B
C	D	B	D	B	D
B	A	A	C	A	B

Despite its agricultural origin, the randomized blocks design is widely used in many types of experiments. For instance, to determine the differences in productivity of different makes of machines (Treatments) we may isolate the possible effects due to differences in efficiency among operators, (blocks) by assigning the machine at random to randomly selected operators. The basic idea here is to compare all treatment effects within a block of experimental material by eliminating the enviromental effects of replicated for each factor class of if the experimental errors are not the same from class to class of this factor.

4. The method of analysis remain simple when data are missing or rejected, and the loss of information due to missing data is smaller than with any other design.

Latin square design :

Latin squares are very extensively used in physical education and sports.

The data are classified according to the different criteria i.e. according to columms, rows and varieties are arranged in a square known as latin square.

The term latin square takes its name from a figure of mathematical puzzle that was studied many years before its use as a plan of experiment. In this design there have to be as many replications as there are treatments.

Assumption in the analysis of Latin square :

The Latin square model assumes that interactions between treatments and row and column grouping are known as existent. Since each treatment occurs only one in each row or column if intraction are present, it is possible for them to cause an apparently significant difference between treatments.

The analysis of variance table for a randomized block design will be in general having the following form.

Source of variation	sum of square	Degrees of freedom	Mean squares
Column Treatments	SSC	(C-1)	MSC = SSC / (C-1)
Row treatments (Block)	SSR	(r-1)	MSR = SSR / (r-1)
Remainder (or Error)	SSE	(r-1)(C-1)	MSE = SSE / (r-1)(C-1)
	SST	rc-1	

SSC = Variation between column means

SSR = Variation between row means

SSE = Variation within or for errors.

SST = Total variation

SMSC = Mean square between column means

MSR = Mean square between row means.

By comparing the treatment mean square with the remainder mean square, we can decide by an f-test whether the treatments have only effect regardless of whether there is a significant variation from block to block.

Advantages of a Completely Randomized Experimental Design :

The following are the main advantages of this type of Design.

i) It is easy to layout the design.

ii) It allows for complete flexibility.

iii) The statistical analysis is relatively simple, even if we do not have the same number

vi) Compute the remainder sum of squares by subtracting the sum of 3,4 and 5 from 2.

vii) Enter these sums of squares in an analysis of variance table and compute the various mean squares.

ANALYSIS OF VARIANCE TABLE

Source of varience	S.S	Degree of freedom	Mean square
Rows	SSR	(n-1)	MSR = SSR / n-1
Columns	SSC	(n-1)	MSC = SSC / n-1
Treatments	SST	(n-1)	MST = SST / n-1

Residual or error	SSE	(n-1)(n-2)	MSC = SSE / (n-1)(n-2)
Total	TTS	n2-1	

viii) The last step is to calculate F by comparing the treatment mean square with the remainder mean square.

Illustration : 1. Five varieties of wheat A, B, C, D and E, were tried. The gross size of the plot was 18 feet x 22 feet, the net plot being 14 feet x 18 feet. Thus the whole experiment occupied an area 90 feet x 110 feet. The plan, the varieties shown in each plot and yields obtained in kgs. are given in the following table.

This is one of the reasons why it is important to choose rows and columns of a particular Latin square in a random way. Interactions of present can then be viewed as random elements that are part of the error treatment.

They below up the error variance and make the test less efficient but their randomization still allows for a valid theoretical test.

Steps in constructing Latin square :

The construction of Latin square involves the following steps.

i) Compute the correction factor by squaring the grand total and dividing it by the number of observation.

ii) Compute the total sum of squares by adding the squares of the individual observations and subtracting the correction factor.

iii) Compute the row sum of squares by adding the squares of the row-sums, dividing by the number of item in a row, and substracting the correction factor.

iv) Compute the column sum of square by adding the squares of the column sums, dividing by the number of items in a column, and subtracting the correction factor.

v) Compute the ‘ treatment’ sum of squares by summing the squares substracting the correction factor.

Squares

1	2	3	4	5
0	100	1936	484	4
25	36	400	2601	64
441	0	9	36	441
81	1225	25	196	324
64	900	16	25	4
611	2261	2386	3342	837

$\alpha\ x^2 = 611 + 2261 + 2386 + 3342 + 837 = 9437$

Treatment	1	2	3	4	5	Total
A	-9	0	+4	+22	-8	+9
B	0	-30	-20	-6	-18	-74
C	+21	+35	+44	+51	-2	+149
D	-8	-6	-3	-14	+2	-29
E	-5	-10	-5	-5	-21	-46

N = 5 x 5 = 25

(i) Total sum of squares = $\alpha x^2 \quad \underline{T}^2 = 9437 - \underline{(9)}^2$

N 25

= 9437 – 3.24 = 9433.76 or 9433.80

Total degrees of freedom = 25-1 = 24

(2) Sum of squares " Between columns "

$= \underline{1} ((-1)^2 + (-11)^2 + 20)^2 + (48)^2 + (-47)^2 - \underline{T}^2$

5 N

$= \underline{1} (1 + 121 + 400 + 2304 + 2209) - 3.24$

5

B	E	C	A	D
90	80	134	112	92
E	D	B	C	A
85	84	70	141	82
C	A	D	B	E
111	90	87	84	69
A	C	E	D	B
81	125	85	76	72
D	B	A	E	C
82	60	94	85	88

Carry out an analysis of variance what inferenee can you draw from the data given ?

Solution : It is a 5 x 5 Latin square. Let us substract 90 from each value, the table value will be as follows:

Columns

Rows	1	2	3	4	5	X for Rows
1	0	-10	+44	+22	+2	+58
2	-5	-6	-20	+51	-8	+12
3	+21	0	-3	-6	-21	-9
4	-9	+35	-5	-14	-18	-11
5	-8	-30	+4	-5	-2	-41
X for columns	-1	-11	+20	+48	-47	

The results of analysis of the above experiment are given below :

THE ANALYSIS OF VARIANCE TABLE

Source of variance	V	S.S.	M.S.	f-ratio observed	f 0.05
Rows	4	1075.0	268.75	2.65	3.26
Columns	4	1003.8	250.95	2.48	3.26
Varieties	4	6139.8	1534.95	15.15	3.26

Error	12	1215.2	101.27	--	
Total	24	9433.8			

The f-ratios for rows and columns are not significant at 5% level while that for varieties is very highly significant. The fact that there are no significant differences between rows and columns shows that the Latin square arrangement has not been advantageous.

Factorial Experiment :

In an endeavour to improve the logical foundations of a scientific experimentation, factorial design has proved one of the most fruitful developments. Factorial experiments permit the experimenter to evaluate the combined effect of two or more experimental variables when used simultaneously. Information obtained from factorial experiments is more complete than that obtained from a series of single factor experiments, in the sense that factorial experiments permit the evaluation of

$= \frac{5035}{5} - 3.24 = 1007 - 3.24 = 1003.76$ or 1003.8

$V = C-1 = 4$

(3) Sum of squares between rows :

$$= \frac{1}{5}\left((58)^2 + (12)^2 + (-9)^2 + (-11)^2 + (-41)^2 \right) - \frac{T^2}{N}$$

$$= \frac{1}{5}\left((3364 + 144 + 81 + 121 + 1681) \right) - 3.24$$

$= \frac{1}{5}(5391) - 3.24$

$= 1078.2 - 3.24 = 1074.96$ or 1075

$V = 4 - 1 = 4$

(4) Sum of squares between treatments :

$= \frac{1}{5}(9)^2 + (-74)^2 + (149)^2 + (-29)^2 + (-46)^2 - \frac{T^2}{N}$

$= \frac{1}{5}(81 + 5476 + 22201 + 841 + 2116) - 3.24$

$= \frac{1}{5}(30715) - 3.24$

$= 6143 - 3.24 = 6139.76 = 6139.8$

Degrees of freedom between treatments.

$= t - 1$ or $5 = 1 = 4$

(6) Residual or Error :

$9433.8 - 1003.8 - 1075 - 6139.8 = 1215.2$

Interaction effects. :

Other important experimental design are as :

Simple Design :

It is simple and direct, its nature is functional. It involves less complicated techniques for gathering data.

Single Group Design :

It is used when the purpose is to be determined the effect of adding or substracting some experimental factor from a particular situation. In this design group is taken on which the effect of manipulated variables is to be examined. Subjects are given an initial test the experimental factor is applied for some period and then followed by the final testing examples :

A (Group) – Initial testing – Yogic excercises –

Flexibility (Six weeks)

Final testing

Flexibility.

Single group design is well suited for measuring physical conditions, physical fitness strength development, flexibility

Revise Group Design :

This is also a single group. In this type of design, the effect of experimental factors, say A and B are to be seen.

Equivalent or related measure design :

It is more complex than single group. In this design experimentor wishes to determine which of the two or more ways of doing a particular things is best, Experimentor select two or more equivalent groups. One group may serve as a control group and the other as an experimental group. In this type of design significant effect of the experimental factor is to be seen. Experimental factor applied to the experimental group. After the definite period of time the different is to be

observed. The control group is not applied experiments but it will participate in the initial testing and final testing. In this design groups can be equated by matching individuals of both the group. Equating can be done on the basis of their scores. Matching means standard of distribution of scores.

In this design chronological age, sex, race, physical condition, previous achievement, intillegence habit, certain personality traits etc. are to be seen for matching and equating the control and experimental groups.

Rotation Group Design :

This design is simply a variation at the single group design as well as equivalent group design. When applied to a single group, it involves two or more cycles. The order of the experimental factor is rotate and each factor is applied in turn of over an adequate period of time to effect demonstrable changes in subjects.

Repeated Measure Design.:

It is a variation of the single group design in which all subjects in a group receive all treatments when the experimenter wishes to evaluate the effect of several treatments, he may expose all subjects to all treatments in a sequence for example, if the group have been exposed a vigorous dancing for a specific period of time and then this group is exposed to callisthenics for another period of time, then the effect of dancing is supposed to have some definite bearing on the subjects while performing calisthenics.

Selected Reference

Allen, T. Harrell, New Methods in Social Science Research, New York: Praeger Publishers, 1978.

Best, John W., and Kahn, James V., “Research in Education,” 5th Ed., New Delhi: Prentice-Hall of India Pvt. Ltd., 1986.

Bhattacharya, Srinibas, Psychometrics & Behavioural Research, New Delhi: Sterling Publishers Pvt. Ltd., 1972

Burgess, Ernest W., “Research Methods in Sociology” in Georges Gurvitch and W.E. Moore (Ed.), Twentieth Century Sociology, New York: New York Philosophical Library, 1949.

Ferber, R., and Verdoorn, P.J., Research Methods in Economics and Business, New York: The Macmillan Company, 1962.

Ghosh, B.N., Scientific Methods and Social Research, New Delhi: Sterling Publishers Pvt. Ltd., 1982.

The another sources

The Research Methods Knowledge Base, 3rd Edition, by William M. K. Trochim (Author), James P. Donnelly (Author)

Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 4th Edition, by John W. Creswell (Author)

Doing Your Research Project (Open Up Study Skills) 5th Edition, by Judith Bell (Author)