CHAPTER VI

ANALYSIS AND RESULTS

INTRODUCTION

In Chapter V, it was discussed in detail as to how the experiment was undertaken. This Chapter aims at giving details regarding the analysis and interpretation of the data collected through the experiment. Also is given the statement of the findings arrived at. This is followed by the discussion of the same.

The hypotheses to be tested in the experiment are given once again for the sake of convenience (Refer Chapter V).

1a. There will be no significant difference between the strategy one (S_1) and strategy two (S_2) in their effectiveness in terms of the achievement of the instructional objectives, in case of all the students together.

1b. There will be no significant difference between the strategy two (S_2) and strategy three (S_3) in their effectiveness, in terms of the achievement of the instructional objectives in case of all the students together.

1c. There will be no significant difference between the strategy one (S_1) and strategy three (S_3) in their effectiveness, in terms of the achievement of the

instructional objectives in case of all the students together.

2a. There will be no significant difference in the achievement of the instructional objectives amongst the students of high level of intelligence when taught through either strategy one (S_1) and strategy two (S_2) or strategy two (S_2) and strategy three (S_3) or strategy one (S_1) and strategy three (S_3).

2b. There will be no significant difference in the achievement of the instructional objectives amongst the students of average level of intelligence when taught through either strategy one (S_1) and strategy two (S_2) or strategy two (S_2) and strategy three (S_3) or strategy one (S_1) and strategy three (S_3).

2c. There will be no significant difference in the achievement of the instructional objectives amongst the students of low level of intelligence when taught through either strategy one (S_1) and strategy two (S_2) or strategy two (S_2) and strategy three (S_3) or strategy one (S_1) and strategy three (S_3).

OR

3a. There will be no significant difference in achievement of the instructional objectives between the students of high and average level of intelligence, or average and low level of intelligence or high and low level of intelligence when taught through strategy one (S_1).

3b. There will be no significant difference in the achieve-
ment of the instructional objectives between the students
of high and average level of intelligence or average and
low level of intelligence or high and low level of
intelligence when taught through strategy two (S_2).

3c. There will be no significant difference in the achieve-
ment of the instructional objectives between the students
of high and average level of intelligence, or average and
low level of intelligence or high and low level of
intelligence when taught through strategy three (S_3).

Strategy one (S_1) is "The PLM + Laboratory demonstration +
Discussion"

Strategy two (S_2) is "The Structured lecture with black-board
+ Laboratory demonstration + Library
reference work"

Strategy three (S_3) is "The Taped Commentary with Charts and
Work-Sheets + Laboratory Demonstration
+ Discussion"

Hypotheses 1a, 1b and 1c come under the objective 2 viz.
to find out the relative effectiveness of the three instruc-
tional strategies namely strategy one (S_1), strategy two (S_2)
and strategy three (S_3); in terms of the achievement of the
instructional objectives in case of all the students together.
Hypotheses 2a, 2b, 2c and 3a, 3b, 3c come under the purview
of the objective 3 viz. to find out the differences in the
effective use of the three instructional strategies namely

strategy one (S_1), strategy two (S_2) and strategy three (S_3) as judged in terms of the achievement of the instructional objectives, by the students of any of the three levels of intelligence separately i.e. the high level, average level and low level of intelligence.

ANALYSIS

The analysis of the experiment is done in two phases. The testing of the hypotheses 1a, 1b and 1c; coming under the purview of objective 2, forms the first phase. This forms the analysis of Latin Square Design for criterion variables i.e. students' performance (in terms of scores) on the three criterion tests. The testing of the hypotheses 2a, 2b and 2c, coming under the objective 3 forms the second phase. This includes the analysis of Randomized Group Design for the criterion variables i.e. the performance (in terms of scores on the three criterion tests) of the students of each level of intelligence, to study differences between strategies. Lastly testing of the hypotheses 3a, 3b and 3c coming under the objective 3, is also included in the second phase. This too covers the analysis of Randomized group design for the criterion variables i.e. the performance (in terms of scores on three criterion tests) of the students of each level of intelligence, to study differences between groups of students of different levels of intelligence in case of each strategy.

FIRST PHASE OF ANALYSIS

ANALYSIS OF LATIN SQUARE DESIGN
FOR CRITERION VARIABLES

The hypotheses to be tested hereunder are 1a, 1b and 1c; which are stated earlier in this Chapter.

As explained in previous Chapter, the experiment followed a 3 X 3 Latin Square Design. To make it convenient for further presentation, the design is once again given in Table 5.

Table 5 : The Latin Square Design adopted in the experiment.

	U_1	U_2	U_3
G_1	S_1 (T_1)	S_3 (T_2)	S_2 (T_3)
G_2	S_2 (T_1)	S_1 (T_2)	S_3 (T_3)
G_3	S_3 (T_1)	S_2 (T_2)	S_1 (T_3)

G = Group   U = Unit
S = Strategy   T = Criterion Test

The details of the procedure of the experiment are already given in the Chapter V.

In brief, three units viz. 1) proteins, 2) carbohydrates and 3) fats; were selected from the course on Elementary Foods and Nutrition to be taught to the 105 second-year class students of the Faculty of Home-Science, the M.S. University of Baroda. These 105 students forming the sample, were divided randomly into three equal groups i.e. each group consisting of 35 students. All the three groups of students were then exposed to all the three units and all the three instructional strategies.

Thus with 35 replicates in each cell, the total number of observations happens to be 315 (9 cells i.e. 9 experimental conditions X 35 replications). Each criterion test was of 25 marks. The original scores earned by the students in three criterion tests are shown in the Table 6.

Table 6 : Original Scores obtained by the students in the three criterion tests.

Sr. No.	Unit U_1			Unit U_2			Unit U_3		
	G_1S_1 (T_1)	G_2S_2 (T_1)	G_3S_3 (T_1)	G_1S_3 (T_2)	G_2S_1 (T_2)	G_3S_2 (T_2)	G_1S_2 (T_3)	G_2S_3 (T_3)	G_3S_1 (T_3)
1	21	20	22	17	16	20	19	13	24
2	24	17	23	25	18	20	24	15	22
3	18	22	14	19	20	14	14	21	16
4.	24	17	18	20	22	07	24	20	14
5	23	13	19	25	10	07	21	12	17
6	15	17	24	18	18	21	18	22	24
7	19	23	21	19	23	17	16	23	18
8	22	22	20	23	24	17	19	23	22

Table 6 (contd..)

Sr. No.	Unit U_1			Unit U_2			Unit U_3		
	G_1S_1 (T_1)	G_2S_2 (T_1)	G_3S_3 (T_1)	G_1S_3 (T_2)	G_2S_1 (T_2)	G_3S_2 (T_2)	G_1S_2 (T_3)	G_2S_3 (T_3)	G_3S_1 (T_3)
9	14	24	24	13	24	21	15	20	23
10	21	25	17	18	23	15	17	17	16
11	19	23	24.	20	24.	25	17	19	23.
12 .	19	19	25	22	23	20	18	17	25
13	20	18	16	12	21	18	17	16	13
14	25	17	21	22	16	21	20	12	19
15	22	22	16	23	20	18	19	20	19
16	18	17	15	16	24.	16	13	24.	24
17	23	19	20	23	22	15	24	11	22
18	15	20	18	15	22	15	13	20	15
19	15.	21	20	17	21	17	08	22	23
20	24	17	24	24	14	24	25	14	20
21	16	14	20	13	19	11	12	09	12
22	18	16	23	17	15	23	18	14	15
23	24	20	17	24	14	15	21	15	13
24	24	12	20	22	10	12	17	05	10
25	19	14	13	23	13	08	22	09	12
26	21	10	21	14	07	19	15	09	22
27	19	05	23	22	06	23	21	02	19
28	21	17	15	19	21	15	17	20	14
29	15	16	20	18	17	19	17	07	22
30	23	12	24	23	13	24	25	11	23

Table 6 (contd..)

Sr. No.	Unit U_1			Unit U_2			Unit U_3		
	$\overline{G_1S_1}$ (T_1)	$\overline{G_2S_2}$ (T_1)	$\overline{G_3S_3}$ (T_1)	$\overline{G_1S_3}$ (T_2)	$\overline{G_2S_1}$ (T_2)	$\overline{G_3S_2}$ (T_2)	$\overline{G_1S_2}$ (T_3)	$\overline{G_2S_3}$ (T_3)	$\overline{G_3S_1}$ (T_3)
31	23	14	17	23	08	13	22	05	14
32	19	16	22	18	17	15	19	16	21
33	20	21	16	24.	11	22	19	11	21
34	22	20	20	21	18	12	11	13	31
35	18	19	19	17	19	12	15	14	11
Total	703	619	691	689	613	591	632	521	641

These scores were used for the further calculations. Analysis of variance was used to find out the relative effectiveness of the instructional strategy one (S_1) and strategy two (S_2); strategy two (S_2) and strategy three (S_3); strategy three (S_3) and strategy one (S_1), from the scores achieved by the students in the three criterion tests.

The important steps of calculations, involved in the first phase of the analysis to find out the F ratio are as follows.

To start with the calculations, for the analysis, the original scores obtained by the students belonging to the three groups i.e. Group one (G_1), Group two (G_2) and Group three (G_3); in all the three instructional strategies i.e. Strategy one (S_1), Strategy two (S_2) and Strategy three (S_3) were added up separately, as mentioned above. The total of scores for each group, for each unit and for each strategy is expressed in

each cell i.e. in each square in the following Table no. 7.

Table 7 : Sum of Scores with their means, as well
as Sum of Squares in each group formed
by Latin Square design with 35 Subjects
in each.

	Unit I	Unit II	Unit III	Total
	(S_1)	(S_3)	(S_2)	
Group I	$\Sigma x = 703$	$\Sigma x = 689$	$\Sigma x = 632$	$2024 = \Sigma G_1$
or	$M = 20.1$	$M = 19.8$	$M = 18.0$	$M = 19.28$
Sequence I	$\Sigma x^2 = 14451$	$\Sigma x^2 = 14023$	$\Sigma x^2 = 11974$	
	$(n = 35)$	$(n = 35)$	$(n = 35)$	$(N = 105)$
	(S_2)	(S_1)	(S_3)	
Group II	$\Sigma x \quad 619$	$\Sigma x \quad 613$	$\Sigma x \quad 521$	$1753 = \Sigma G_2$
or	$M = 17.7$	$M = 17.5$	$M = 15.0$	$M = 16.59$
Sequence II	$\Sigma x^2 = 11561$	$\Sigma x^2 = 11675$	$\Sigma x^2 = 8867$	
	$(n = 35)$	$(n = 35)$	$(n = 35)$	$(N = 105)$
	(S_3)	(S_2)	(S_1)	
Group III	$\Sigma x = 691$	$\Sigma x = 591$	$\Sigma x = 641$	$1923 = \Sigma G_3$
or	$M = 19.8$	$M = 17.0$	$M = 18.3$	$M = 18.31$
Sequence III	$\Sigma x^2 = 14003$	$\Sigma x^2 = 10765$	$\Sigma x^2 = 12433$	
	$(n = 35)$	$(n = 35)$	$(n = 35)$	$(N = 105)$
Total	$\Sigma U_1 = 2013$	$\Sigma U_2 = 1893$	$\Sigma U_3 = 1794$	$\Sigma x = 5700$
	$M = 19.17$	$M = 18.03$	$M = 17.09$	$\Sigma x^2 = 109752$
	$(N = 105)$	$(N = 105)$	$(N = 105)$	$(N = 315)$

S = Instructional Strategy

Σx = Total of original scores in the criterion test

M = Mean

Σx^2 = Sum of squares of the original scores

n = Number of observations (students) in one group

N = Total number of observations (students) in three groups

$\leqslant G_1$, $\leqslant G_2$, $\leqslant G_3$ = Total scores obtained by Group I, Group II and Group III respectively, in the three criterion tests of the three corresponding units taught through the three different strategies.

$\leqslant U_1$, $\leqslant U_2$, $\leqslant U_3$ = Total score obtained by all the three groups in the criterion tests of Unit I, Unit II and Unit III respectively, each taught through a different strategy.

Referring to the same table 7, the total score for each strategy was also computed separately. The same is given herebelow in Table 8.

Table 8 : Total score and the mean score of Strategy S_1, S_2 and S_3

Instructional Strategy	Total Score of G_1 G_2 G_3	Total Score of three groups	No. of observations	Mean Score
Strategy one (S_1)	703+613+641	1957	105	18.64
Strategy two (S_2)	632+619+591	1842	105	17.54
Strategy three (S_3)	689+521+691	1901	105	18.10

As table 7 indicates there are 3 rows and 3 columns, with 35 subjects in each cell, which is being replicated 35 times. Thus there are 35 X 3 = 105 subjects and 35 X 3 X 3 = 315 observations.

The different steps of analysis of variance are shown below.

(Refer to table no. 7 for the figures used in the following calculations)

$$\Sigma x = 5700$$
$$\therefore (\Sigma x)^2 = (5700)^2$$
$$\therefore (\Sigma x)^2 = 32490000$$

$$C = \frac{(\Sigma x)^2}{N}$$
$$= \frac{32490000}{315}$$
$$= 103142.85$$

$$SS_{Total} = \Sigma x^2 - C$$
$$= 109752 - 103142.85$$
$$= 6609.15$$

$$SS_{Treatment \ (methods \ or \ strategies)} = \frac{(\Sigma S_1)^2 + (\Sigma S_2)^2 + (\Sigma S_3)^2}{105} - C$$
$$= \frac{(1957)^2 + (1842)^2 + (1901)^2}{105} - 103142.85$$
$$= \frac{3829849 + 3392964 + 3613801}{105} - 103142.85$$
$$= \frac{10836614}{105} - 103142.85$$
$$= 103205.84 - 103142.85$$
$$= 62.99$$

$$SS_{Columns \ (unit)} = \frac{(\Sigma U_1)^2 + (\Sigma U_2)^2 + (\Sigma U_3)^2}{105} - C$$
$$= \frac{(2013)^2 + (1893)^2 + (1974)^2}{105} - 103142.85$$
$$= \frac{4052169 + 3583449 + 3218436}{105} - 103142.85$$
$$= \frac{10854054}{105} - 103142.85$$
$$= 103371.94 - 103142.85$$
$$= 229.09$$

$$SS_{Subjects \atop (Rows)} = \frac{(\leq S_1)^2 + (\leq S_2)^2 + (\leq S_3)^2 \ldots + (\leq S_{105})^2}{3} - C$$

$$= \frac{(57)^2 + (73)^2 + (51)^2 \ldots + (42)^2}{3} - 103142.85$$

$$(\text{For 3 groups}) = \frac{120162 + 94425 + 108483}{3} - 103142.85$$

$$= \frac{323070}{3} - 103142.85$$

$$= 107690 - 103142.85'$$

$$= 4547.15$$

This includes $SS_{Seq.}$ or SS_{group} and the residual error (a).

$$SS_{Seq. \atop (group)} = \frac{(\leq G_1)^2 + (\leq G_2)^2 + (\leq G_3)^2}{105} - C$$

$$= \frac{(2024)^2 + (1753)^2 + (1923)^2}{105} - 103142.85$$

$$= \frac{4096576 + 3073009 + 3697929}{105} - 103142.85$$

$$= \frac{10867514}{105} - 103142.85$$

$$= 103500.13 - 103142.85$$

$$= 357.28$$

$$SS_{Cells} = \frac{(\leq G_1 U_1)^2 + (\leq G_1 U_2)^2 \ldots + (\leq G_3 U_3)^2}{35} - C$$

$$= (703)^2 + (689)^2 + (632)^2 + (619)^2 + (613)^2 + (521)^2 + (691)^2$$
$$(591)^2 + (641)^2 / 35 - 103142.85$$

$$= \frac{494209 + 474721 + 399424 + 383161 + 375769 + 271441 + 477481}{+349281 + 410881} / 35 - 103142.85$$

$$= \frac{3636368}{35} - 103142.85$$

$$= 103896.22 - 103142.85$$

$$= 753.37$$

$$SS_{\text{Latin Sq. Error}} = SS_{\text{cells}} - SS_{\text{Seq.}} - SS_{\text{Unit}} - SS_{\text{Treatment}}$$

$$= 753.37 - 357.28 - 229.09 - 62.99$$

$$= 104.01$$

$$SS_{\text{Error(a)}} = SS_{\text{Subjects}} - SS_{\text{Seq.}} \quad (\text{with } 104-2 = 102 \text{ df})$$

$$= 4547.15 - 357.28$$

$$= 4189.87$$

This is pooled sum of Sequences between subjects tested with the same sequence and as such serves the error term (a) for testing sequence.

$$SS_{\text{Residual Error (b)}} = SS_{\text{Total}} - SS_{\text{Treatments}} - SS_{\text{Unit}} - SS_{\text{Subject}}$$

$$= 6609.15 - 62.99 - 229.09 \_ 4547.15$$

$$= 1769.92$$

This residual error (b) with degree of freedom 206, is made up of two parts : 1) Pooled sum of squares of subjects (rows) X Unit (colu.) i.e. 35 times 2 X 2 = 140 degree of freedom and the residual Latin Square error with 66 degree of freedom.

Pooled sum of squares of Ss X Us i.e. (rows X cols.) interaction can actually be calculated for each seq. (9 scores in each G X U square) with 2 X 2 = 4 df., repeating these for 35 times (35 squares) with 35 X 2 X 2 = 140 df.

However this Residual Error (b) with Latin Square error and pooled Ss X Us can also, for convenience, be calculated by substraction; thus :

$SS_{\text{Residual Error (b)}} - SS_{\text{Latin Sq. Error}}$ = Pooled Sum of Squares

of $SS_{\text{Subjects X Unit}}$

with 35 x 2 x 2 = 140 df

$SS_{\text{Residual Error (b)}} - SS_{\text{Latin Sq. Error}}$ = Pooled (Ss x Us) SS

= 1769.92 - 104.01 = 1665.91

Thus the different sum of squares calculated are summarized as below.

1) Sum of squares among strategies or
   treatments (methods)   =   62.99

2) Sum of squares among units (columns)   =   229.09

3) Sum of squares among subjects +
   sequence (raws)   = 4547.15

4) Sum of squares among sequence   =   357.28

5) Sum of squares for Error (a)   = 4189.87

6) Sum of squares for Residual Error (b)   = 1769.92

7) Sum of squares for Pooled $SS_{\text{seq.}}$ x Units
   (35 x 2 x 2)   = 1665.91

8) Sum of squares for Latin Square Error   =   104.01

Table 9 presents the summary of the analysis of variance of the criterion scores.

Table 9 : Summary of ANOVA of the Criterion Scores

Source of Variance	df	SS	MS	F ratio	Level of Significance
Strategies (Treatments or methods)	2	62.99	31.49	$MS_{TR}/MS_{E(b)}=$ $\frac{31.49}{8.59} = 3.66$	.05
Coumns (units)	2	229.09	114.54	$MS_u/MS_{E(b)}=$ $\frac{114.54}{8.59}=13.33$	beyond .01
Rows (subjects + sequence)	104	4547.15	43.72		
Sequence	2	357.28	178.64	$MS_{seq.}/MS_{E(a)}=$ $\frac{178.64}{41.08} = 4.35$	.05
Error(a)	102	4189.87	41.08		
Residual Error(b)	206	1769.92	8.59		
Pooled $SS_{seq.}$ x Units (35x2x2)	140	1665.91	11.90		
Latin Sq. Error	66	104.01	1.57		
	314	6609.15			

It will be seen from the results in the above table that the F ratio for the strategies; units of teaching and sequence of presentation, obtained after dividing the mean sum of squares by the appropriate error term as shown in the table, were statistically significant at 0.05, beyond 0.01 and

0.05 levels respectively. This shows that all these three sources namely strategies, teaching units and the sequence of presentation contributed significantly to the achievement of the instructional objectives. To be more specific the instructional strategies were significantly different on the whole. However in order to study the significance of difference of each pair namely S_1-S_2, S_2-S_3 and S_1-S_3; Least Significance Difference Test (extension of t-test) was used.

Results of the Least Significant Difference (L.S.D.) Test:

It can be seen from the table 9, that strategies contributed significantly at 0.05 level (F being 3.66 for df 2/206) i.e. strategies one (S_1), two (S_2) and three (S_3) differed significantly on the whole. In order to find out which one differs from which one, it was thought advisable to use L.S.D. Test (Least Significant Difference Test) i.e. extension of t-test where $D = SE_D \times t$ $SE_D = \sqrt{2MS_{Er(b)}/n}$; where n = number of scores in each strategy which is 105; 't' at 0.05 level for df = df for $MS_{error(b)}$ = 206; is to be seen from tables, which is 1.97 at 0.05 level of significance; and 2.60 at .01 level of significance.

$$\text{Thus} \quad SE_D = \sqrt{\frac{2 \times 8.59}{105}}$$

$$= \sqrt{0.163619}$$

$$= 0.404498$$

∴ D = 0.404498 x 1.97 = 0.79868 at .05 level of significance

0.404498 x 2.60 = 1.05169 at .01 level of significance.

The results of L.S.D. Test are shown in the following Table 10 to understand the differences between the mean scores of each pair of strategies. (For mean scores refer Table no.8)

Table 10 : The significance of difference between mean scores of each pair of strategies

Strategies	Mean Score	Difference	Level of Significance
$(S_1) - (S_2)$	18.64 - 17.54	1.10	.01
$(S_1) - (S_3)$	18.64 - 18.10	0.54	NS
$(S_3) - (S_2)$	18.10 - 17.54	0.56	NS

It can be seen from the above table of differences that strategy one (S_1) differed significantly from strategy two (S_2) at .01 level of significance. This means that the effectiveness of strategy one (S_1) and strategy two (S_2) is significantly different from each other, in terms of the x achievement of the instructional objectives. Therefore the null hypothesis 1a that there will be no significant diffe- rence between strategy one (S_1) and strategy two (S_2) in their effectiveness, in terms of the achievement of the instructional objectives, is rejected at 0.01 level of significance.

As the same table 10 indicates, the strategy two (S_2) does not differ significantly from strategy three (S_3) at .01 level of significance. This means that the effectiveness

of strategy two (S_2) and strategy three (S_3) is not signifi-
cantly different from each other in terms of the achievement
of the instructional objectives. Therefore the null hypothesis
1b that there will be no significant difference between
strategy two (S_2) and strategy three (S_3) in their effective-
ness in terms of achievement of the instructional objectives
is not rejected.

Further as the same table 10 shows, strategy one (S_1)
does not differ significantly from strategy three (S_3) at
.01 level of significance. This means that effectiveness of
strategy one (S_1) and strategy three (S_3) is not significantly
different in terms of the achievement of the instructional
objectives. Therefore the null hypothesis 1c that there
will be no significant difference between strategy one (S_1)
and strategy three (S_3) in their effectiveness, in terms of
the achievement of the instructional objectives is not
rejected.

Thus in brief it is proved that strategy one (S_1) differed
significantly in its relative effectiveness, in terms of achie-
vement of the instructional objectives from strategy two (S_2);
at .01 level of significance. There was no significant
difference found between the strategy two (S_2) and strategy
three (S_3); and between strategy one (S_1) and strategy (S_3);
in the same terms.

However to examine whether strategy one (S_1) differed
from strategy two (S_2) in case of all the units or not, again
L.S.D. Test was used with reference to the pair of strategies

viz. strategy one (S_1) and strategy two (S_2) for Unit 1, Unit 2 and Unit 3; where $MS_{E(b)}$ remains the same i.e. 8.59 and n = 35. Following the same procedure as shown earlier, the expected significant differences when calculated, were, 1.42 at 0.05 level of significance and 1.90 at 0.01 level of significance. Referring to the means in each cell concerned in the table 7, the results of the L.S.D. Test are given below in the Table 11.

Table 11 : The Significance of Difference between Mean Scores of Strategy one (S_1) and Strategy two (S_2) in relation to the three units.

Units	Mean Scores	Difference	Level of Significance
	(S_1) - (S_2)		
Unit$_1$	20.1 - 17.7	2.3	.01
Unit$_2$	17.5 - 17.0	0.5	NS
Unit$_3$	18.3 - 18.0	0.3	NS

This shows that, though on the whole strategy one (S_1) was better than the strategy two (S_2) further analysis revealed that strategy one (S_1) was more effective than strategy two (S_2) only in case of learning (achieving the instructional objectives) unit$_1$ on 'proteins' and not the unit$_2$ on 'carbo-hydrates' and unit$_3$ on 'fats'.

Similarly L.S.D. test was also used with respect to units and sequence of its presentation to find out significance

of difference between each pair of units. In case of units, the expected significant gap is 0.80 at 0.05 level of significance and 1.05 at 0.01 level of significance since $MS_{E(b)}$ = 8.59 and N = 105. Referring to the means in each cell concerned in the table 7, the results of the L.S.D. test are given below in the Table 12.

Table 12 : The Significance of Difference between
mean scores of each pair of units

Units	Mean Scores	Difference	Level of Significance
$Unit_1$ – $Unit_2$	19.17 – 18.03	1.14	.01
$Unit_2$ – $Unit_3$	19.17 – 17.09	2.08	.01
$Unit_2$ – $Unit_3$	18.03 – 17.09	0.94	.05

The above table reveals that each unit is significantly different from the other. $Unit_1$ on 'proteins' was learnt most advantageously. Next most effective unit in learning was $unit_2$ on 'carbohydrates', while $unit_3$ on fats was mastered not as much as the other two units on the whole.

However in order to examine whether these differences were significant in cae of each strategy or not L.S.D. test was again used with reference to these differences in strategy (S_1), strategy two (S_2) and strategy three (S_3); where $MS_{E(b)}$ remains the same (8.59) and N = 35. Following the same procedure the expected significant differences when computed, were 1.42 at 0.05 level and 1.90 at 0.01 level. Referring

to means in the cells concerned in the table 7, the results
are given below.

Table 13 : The Significance of Difference between
Mean Scores of Each pair of Units in
Relation to the Three Strategies.

Str-ategy	Mean Scores Diff. $U_1 - U_2$		Level of Sig.	Mean Scores Diff. $U_1 - U_3$		Level of Sig.	Mean Scores Diff. $U_2 - U_3$		Level of Sig.
(S_1)	20.1 - 17.5	2.6	.01	20.1 - 18.3	1.8	0.05	17.5 - 18.3	-0.8	NS
(S_2)	17.7 - 17.0	0.7	NS	17.7 - 18.0	-0.3	NS	17.0 - 18.0	-1.0	NS
(S_3)	19.8 - 19.8	0	NS	19.8 - 15.0	4.8	0.01	19.8 - 15.0	4.8	.01

Although it was proved that units were significantly
different on the whole (refer table 9); the above table shows
that the difference between $Unit_1$ and $Unit_2$ is actually sig-
nificant ($Unit_1$ was learnt the best) in case of strategy one
and not in the other two strategies. Similarly the difference
between $Unit_1$ and $Unit_3$ is truly significant in case of stra-
tegy one (S_1) and strategy three (S_3) ($Unit_1$ is learnt the
best); and not in case of strategy two (S_2). So also the
difference between $Unit_2$ and $Unit_3$ is significant only in case
of strategy three (S_3) ($Unit_2$ is learnt the best) and not in
other two strategies.

The L.S.D. test was also used with respect to the
sequence of presentation where $MS_{E(a)}$ is 4.35 and N = 105 on
the whole and N = 35 for each sub-group.

The expected significant differences are –

$$D = t \times SE_D \quad \text{where } SE_D = \sqrt{2\ MS_{E}/n}$$

$$SE_D = \sqrt{2 \times \frac{4.35}{105}} = 0.29 \text{ on the whole}$$

$$= \sqrt{2 \times \frac{4.35}{35}} = 0.5 \text{ for each sub group}$$

Therefore –

$$D = 1.97 \times 0.29 = 0.57 \quad \text{at } 0.05 \text{ level of significance on the whole}$$

$$= 2.60 \times 0.29 = 0.75 \quad \text{at } 0.01 \text{ level of significance on the whole}$$

and

$$= 1.97 \times 0.5 = 0.985 \quad \text{at } 0.05 \text{ level of significance for sub group}$$

$$= 2.60 \times 0.5 = 1.30 \quad \text{at } 0.01 \text{ level of significance for sub group}$$

Referring to the means in each cell concerned (sequence total) in the table 7 the results of the significance of differences are given below in the table 14.

Table 14 : The Significance of the Difference between Mean Scores of Sequences

Sequence	Mean Scores	Difference	Level of Significance
$Seq._1 - Seq._2$	19.28 – 16.69	2.59	.01
$Seq._1 - Seq._3$	19.28 – 18.31	0.97	.01
$Seq._2 - Seq._3$	16.69 – 18.31	–1.62	.01

The above table shows that each sequence is significantly different from the other on the whole. However in a Latin Square arrangement only one sequence appears once in each row and hence sequence differences for each method are not possible to know. We have thus to be contented with knowing that the sequences difference is significant on the whole and not strategy-wise.

SECOND PHASE OF THE ANALYSIS

The second phase of the experiment included analysis of variance for the Randomized Group Design in two parts viz. (I) when data were analysed for the each level of intelligence individually to study differences between the instructional strategies; and (II) when data were analysed for the each instructional strategy separately to study differences between groups of students of different levels of intelligence. The above mentioned part I tested the hypotheses 2a, 2b and 2c; and part II tested the hypotheses 3a, 3b and 3c.

As stated earlier in Chapter V, all the 105 experimental subjects i.e. the second year B.Sc.(Home) students were given an intelligence test called Ravan's Standard Progressive Matrices. After the administration of the test, the test papers were corrected exactly according to the key given in the mannual for the test. This test was out of 60 marks. The scores obtained by the students in the said test were then translated into percentile rank. The students could be thus,

divided into theree catagoris as (i) students of high level
of intelligence (ii) tne students of average level of intelli-
gence and (iii) the students of low level of intelligence.
To be more pracise and specific, the students obtaining 52
marks and above i.e. corresponding to above 75th percentile
formed the group of 'high intelligence level'. Students
securing 39 to 51 marks i.e. corresponding to, between 25th
and 75th percentile formed the another group of 'average
intelligence level'; and lastly the students achieving 38
marks and below i.e. corresponding to below 25th percentile
formed the third group of 'low intelligence level'. Thus
there were 31, 47 and 27 students belonging to the high
level of intelligence, average level of intelligence and
low level of intelligence, respectively.

The summary of the total as well as mean score on each
strategy among different groups of intelligence with the (n)
number of students in each cell is given in the following table.

Table 15 : Total and Mean Scores on each Instruc-
tional Strategy, among different groups
of Intelligence.

	Strategy S_1	Strategy S_2	Strategy S_3	Total
Students of High level of intelligence	$\Sigma x = 611$ $M = 19.71$ $(n = 31)$	$\Sigma x = 603$ $M = 19.45$ $(n = 31)$	$\Sigma x = 579$ $M = 18.68$ $(n = 31)$	$\Sigma x = 1793$ $M = 19.28$ $(n = 93)$

Table 15 (contd..)

	Strategy S_1	Strategy S_2	Strategy S_3	Total
Students of Average level of intelligence	$\leq x = 881$ $M = 18.74$ $(n = 47)$	$\leq x = 793$ $M = 16.87$ $(n = 47)$	$\leq x = 861$ $M = 18.32$ $(n = 47)$	$\leq x = 2535$ $M = 17.98$ $(n = 47)$
Students of Low level of intelligence	$\leq x = 465$ $M = 17.22$ $(n = 27)$	$\leq x = 446$ $M = 16.52$ $(n = 27)$	$\leq x = 461$ $M = 17.07$ $(n = 27)$	$\leq x = 1372$ $M = 16.94$ $(n = 81)$
Total	$\leq x = 1957$ $M = 18.64$ $(N = 105)$	$\leq x = 1842$ $M = 17.54$ $(N = 105)$	$\leq x = 1901$ $M = 18.10$ $(N = 105)$	$\leq x = 5700$ $GM = 18.09$ $(N = 315)$

n = number of students in a group

N = Total number of students in three groups

$\leq x$ = Total score

M = Mean score

GM = Grand Mean

This was followed by the analysis of the data using analysis of variance for the randomized group design.

PART I

ANALYSIS OF VARIANCE FOR THE RANDOMIZED GROUP DESIGN (for each level of intelligence separately)

(a) R.G.D. for High Level of Intelligence :

To test the hypothesis 2a that there will be no significant difference in the achievement of the instructional objectives amongst the students of high level of intelligence when taught through either strategy one (S_1) and strategy two

(S_2) or strategy two (S_2) and strategy three (S_3) or strategy
one (S_1) and strategy three (S_3), their scores in the three
criterion tests for all the three units taught through three
strategies were recorded separately. The same scores recorded
strategywise were added up to make the total score for each
strategy. Also the individual raw score for each strategy
was squared up and the total of the squared up scores was also
made. The same is shown in the table below.

Table 16 : Scores achieved by the Students of
High Level of Intelligence; in the
Criterion Tests.

Sr. No.	Strategy one (S_1)		Strategy two (S_2)		Strategy three (S_3)	
	Original Score	Square	Original Score	Square	Original Score	Square
1	21	441	17	289	19	361
2	24	576	25	625	25	625
3	24	576	17	289	16	256
4	23	529	17	289	20	400
5	20	400	20	400	24	576
6	25	625	12	144	23	529
7	24	576	14	196	15	225
8	18	324	16	256	24	576
9	24	576	21	441	16	256
10	24	576	07	049	17	289
11	19	361	20	400	25	625
12	23	529	18	324	20	400

Table 16 (contd..)

Sr. No.	Strategy one (S_1)		Strategy two (S_2)		Strategy three (S_3)	
	Original Score	Square	Original Score	Square	Original Score	Square
13	23	529	17	289	25	625
14	22	484	24	576	12	144
15	23	529	23	529	22	484
16	16	256	15	225	24	576
17	14	196	24	576	17	289
18	14	196	22	484	24	576
19	13	169	19	361	22	484
20	08	064	24	576	22	484
21	17	289	24	576	23	529
22	11	121	21	441	23	529
23	17	289	17	289	20	400
24	25	625	20	400	17	289
25	19	361	25	625	12	144
26	23	529	18	324	14	196
27	20	400	21	441	15	225
28	19	361	17	289	11	121
29	14	196	21	441	05	025
30	23	529	25	625	16	256
31	21	441	22	484	11	121
Total	611	12653	603	12253	579	11615

The same data were then analysed using the analysis of variance. The necessary detailed steps of calculations for

the F ratio are as follows:

$$n = 31 \quad + \quad n = 31 \quad + \quad n = 31$$

$$\therefore \ N = 93$$

$$\Sigma x = 611 + 603 + 579 = 1793$$

$$\therefore \ (\Sigma x)^2 = 3214849$$

$$C = \frac{(\Sigma x)^2}{N}$$

$$C = \frac{3214849}{93}$$

$$C = 34568.268$$

$$\Sigma x^2 = 12653 + 12253 + 11615$$

$$= 36521$$

$$SS_T = \Sigma x^2 - C$$

$$= 36521 - 34568.268$$

$$= 1952.732$$

$$SS_B = \frac{(\Sigma S_1)^2 + (\Sigma S_2)^2 + (\Sigma S_3)^2}{n} - C$$

$$= \frac{(611)^2 + (603)^2 + (579)^2}{31} - 34568.268$$

$$= \frac{1072171}{31} - 34568.268$$

$$= 34586.161 - 34568.268$$

$$= 17.893$$

$$SS_w = SS_T - SS_B$$

$$= 1952.732 - 17.893$$

$$= 1934.839$$

Thus,

Sum of squares between the cells = 17.893

Sum of squares within the cells = 1934.839

The following table gives the summary of results of analysis of variance on data treated under randomized group design for the students of high level of intelligence.

Table 17 : The Summary of results of Analysis of variance on Data Treated by Randomized group design for the performance of the Students of High Level of Intelligence, under three strategies.

Source of Variance	df	SS	MS	F Ratio	Level of significance
SS_B (Strategies)	2	17.893	8.95	0.416	NS
SS_W (Error)	90	1934.839	21.50		
	92	1952.732			

The above table shows that the F ratio for the strategies viz. 0.416 for df 2/90 is not significant at 0.01 level of significance. This means that there are no differences in the achievement of the instructional objectives by the students of high level of intelligence when taught through strategy one (S_1) and strategy two (S_2); strategy two (S_2) and strategy three (S_3); or strategy three (S_3) and strategy one (S_1). This in turn suggests that the relative effectiveness of all the three instructional strategies is the same

in terms of the achievement of the instructional objectives for the students of high level of intelligence.

Therefore the null hypothesis 2a, that there will be no significant difference in the achievement of the instructional objectives amongst the students of high level of intelligence when taught through either strategy one (S_1) and strategy two (S_2), or strategy two (S_2) and strategy three (S_3); or strategy one (S_1) and strategy three (S_3) is not rejected.

This concludes that knowledge can be achieved effectively by the students of high level of intelligence, no matter which strategy (out of the three strategies included in the experiment) they are taught through.

(b) R.G.D. for Average Level of Intelligence :

To test the hypothesis 2b that there will be no significant difference in the achievement of the instructional objectives, amongst the students of average level of intelligence, when taught through either strategy one (S_1) and strategy two (S_2), or strategy two (S_2) and strategy three (S_3), or strategy one (S_1) and strategy three (S_3), their scores in the three criterion tests for all the three units, taught through the three strategies were recorded separately. The same scores recorded strategywise were added up to make the total score for each strategy. Also the individual raw score for each strategy was squared up and the total of the squared up scores was also made. The same is shown in the table below.

Table 18 : Scores achieved by the Students of
Average Level of Intelligence in the
Criterion Tests.

Sr. No.	Strategy one (S_1)		Strategy two (S_2)		Strategy three (S_3)	
	Original Score	Square	Original Score	Square	Original Score	Square
1	18	324	20	400	23	529
2	15	225	17	289	18	324
3	22	484	13	169	24	576
4	21	441	17	289	20	400
5	19	361	23	529	24	576
6	19	361	22	484	24	576
7	22	484	23	529	15	225
8	18	324	19	361	20	400
9	16	256	18	324	20	400
10	21	441	22	484	23	529
11	21	441	17	289	17	289
12	15	225	20	400	20	400
13	22	484	21	441	13	169
14	16	256	14	196	21	441
15	18	324	16	256	17	289
16	10	100	12	144	22	484
17	18	324	14	196	19	361
18	23	529	20	400	18	324
19	24	576	20	400	23	529
20	24	576	07	049	18	324
21	23	529	21	441	20	400
22	21	441	17	289	22	484

Table 18 (contd..)

Sr. No.	Strategy one(S_1)		Strategy two(S_2)		Strategy three(S_3)	
	Original Score	Square	Original Score	Square	Original Score	Square
23	20	400	21	441	23	529
24	24	576	25	625	16	256
25	22	484	16	256	13	169
26	21	441	15	225	14	196
27	19	361	11	121	19	361
28	15	225	23	529	18	324
29	10	100	15	225	21	441
30	13	169	12	144	13	169
31	18	324	08	064	15	225
32	22	484	19	361	12	144
33	14	196	13	169	22	484
34	24	576	15	225	23	529
35	22	484	14	196	23	529
36	23	529	18	324	19	361
37	23	529	19	361	17	289
38	24	576	17	289	16	256
39	22	484	17	289	20	400
40	12	144	18	324	24	576
41	15	225	19	361	20	400
42	13	169	13	169	22	484
43	10	100	12	144	09	081
44	12	144	15	225	14	196

Table 18 (contd..)

Sr. No.	Strategy one(S_1)		Strategy two(S_2)		Strategy three(S_3)	
	Original Score	Square	Original Score	Square	Original Score	Square
45	22	484.	17	289	05	025
46	14	196	17	289	09	081
47	21	441	11	121	13	169
Total	881	17347	793	14125	861	16703

The same data were then analysed using the analysis of variance. The necessary detailed steps of calculations for the F ratio are as follows:

$$n = 47 + n = 47 + n = 47$$

$$\therefore N = 141$$

$$\Sigma x = 881 + 793 + 861$$

$$= 2535$$

$$(\Sigma x)^2 = 6426225$$

$$C = \frac{(\Sigma x)^2}{N} = \frac{6426225}{141} = 45576.063$$

$$\Sigma x^2 = 17347 + 14125 + 16703 = 48175$$

$$SS_T = \Sigma x^2 - C$$

$$= 48175 - 45576.063$$

$$= 2598.937$$

$$SS_B = \frac{(881)^2 + (793)^2 + (861)^2}{n} - C$$

$$= \frac{776161 + 628849 + 741321}{47} - 45576.063$$

$$= \frac{2146331}{47} - 45576.063$$

$$= 45666.617 - 45576.063$$

$$= 90.554$$

$$SS_W = SS_T - SS_B$$

$$= 2598.937 - 90.554$$

$$= 2508.383$$

Thus

Sum of squares between the cells = 90.554

Sum of squares within the cells = 2508.383

The following Table gives the summary of results of analysis of variance on the data treated under randomized group design, for the students of average level of intelligence.

Table 19 : The Summary of Results of Analysis of Variance on Data Treated by Randomized Group Design for the performance of the Students of Average Level of Intelligence under three Strategies.

Source of Variance	df	SS	MS	F ratio	Level of Significance
SS_B (strategies)	2	90.554	45.27	2.49	NS
SS_W (Error)	138	2508.383	18.18		
	140	2598.937			

The above table reflects that the F ratio for the strategies viz. 2.49 for df 2/138 is not significant at .01

level of significance. This means that there are no signifi-
cant differences in the achievement of the instructional
objectives by the students of average level of intelligence
when taught through strategy one (S_1) and strategy two (S_2),
or strategy two (S_2) and strategy three (S_3), or strategy
three (S_3) and strategy one (S_1). This in turn suggests that
the relative effectiveness of all the three instructional
strategies is the same in terms of the achievement of the
instructional objectives for the students of average level of
intelligence, (though the f value obtained is very near to
just significant, f required, being 3.09 at 0.05 level of
significance).

Therefore the null hypothesis 2b that there will be no
significant difference in the achievement of the instructio-
nal objectives amongst the students of average level of
intelligence when taught through either strategy one (S_1)
and strategy two (S_2), or strategy two (S_2) and strategy
three (S_3), or strategy one (S_1) and strategy three (S_3) is
accepted.

This leads to a conclusion that the instructional
objectives can be achieved effectively by the students of
average level of intelligence, no matter which strategy
(out of the three strategies included in the experiment)
they are taught through.

(c) R.G.D. for Low Level of Intelligence :

To test the hypothesis 2c, that there will be no

significant difference in the achievement of instructional objectives amongst the students of low level of intelligence when taught through either strategy one (S_1) and stragegy two (S_2), or strategy two (S_2) and strategy three (S_3), or strategy one (S_1) and strategy three (S_3), their scores in the three criterion tests for all the three units, taught through the three strategies were recorded separately. The same scores recorded strategywise were added up to make the total score for each strategy. Also the individual raw score for each strategy was squared up and the total of the squared up scores was also made. The same is presented in the table below.

Table 20 : Scores achieved by the Students of Low Level of Intelligence in the Criterion Tests

Sr. No.	Strategy one(S_1)		Strategy two(S_2)		Strategy three(S_3)	
	Original Score	Square	Original Score	Square	Original Score	Square
1	19	361	22	484	22	484
2	14	196	24	576	14	196
3	23	529	19	361	21	441
4	15	225	10	100	17	289
5	15	225	05	025	16	256
6	19	361	17	289	21	441
7	19	361	16	256	18	324
8	20	400	19	361	20	400
9	18	324	20	400	20	400
10	20	400	14	196	19	361

Table 20 (contd..)

Sr. No.	Strategy one(S_1)		Strategy two(S_2)		Strategy three(S_3)	
	Original Score	Square	Original Score	Square	Original Score	Square
11	24	576	17	289	19	361
12	22	484	15	225	13	169
13	07	049	18	324	23	529
14	06	036	21	441	15	225
15	21	441	15	225	17	289
16	17	289	19	361	23	529
17	19	361	12	144	18	324
18	24	576	12	144	24	576
19	16	256	16	256	17	289
20	18	324	15	225	21	441
21	16	256	24	576	20	400
22	13	169	13	169	11	121
23	19	361	08	064	09	081
24	15	225	22	484	02	004
25	22	484	19	361	20	400
26	13	169	19	361	07	049
27	11	121	15	225	14	196
Total	465	8559	446	7922	461	8575

The same data were then analysed applying the analysis of variance.

The necessary detailed steps calculated for the F ratio are as follows:

$$n = 27 + n = 27 + n = 27$$

$$\therefore N = 81$$

$$\leq X = 465 + 446 + 461$$

$$= 1372$$

$$(\leq X)^2 = (1372)^2$$

$$= 1882384$$

$$c = \frac{(\leq X)^2}{N}$$

$$= \frac{1882384}{81}$$

$$= 23239.308$$

$$\leq X^2 = 8559 + 7922 + 8575$$

$$= 25056$$

$$SS_T = \leq X^2 - c$$

$$= 25056 - 23239.308$$

$$= 1816.692$$

$$SS_B = \frac{(\leq s_1)^2 + (\leq s_2)^2 + (\leq s_3)^2}{n} - c$$

$$= \frac{(465)^2 + (446)^2 + (461)^2}{27} - c$$

$$= \frac{216225 + 198916 + 212521}{27} - 23239.308$$

$$= \frac{627662}{27} - 23239.308$$

$$= 23246.74 - 23239.308$$

$$= 7.432$$

$$SS_w = SS_T - SS_B$$

$$= 1816.692 - 7.432$$

$$= 1809.26$$

Thus

Sum of squares between the cells = 7.432

Sum of squares within the cells = 1809.26

The following Table gives the summary of results of analysis of variance on data treated under randomized group design for the students of low level of intelligence.

Table 2l : The Summary of Results of Analysis of Variance on Data Treated by Randomized Group Design for the performance of the Students of Low Level of Intelligence under three Strategies.

Source of Variance	df	SS	MS	F ratio	Level of Significance
SS_B (Strategies)	2	7.432	3.72	0.160	NS
SS_W (Error)	78	1809.260	23.20		
	80	1816.692			

As can be read from the above table, the F ratio for the strategies viz. 0.160 for df 2/78 is not significant at 0.01 level of significance. This means that there are no differences in the achievement of the instructional objectives by the students of low level of intelligence when taught through strategy one (S_1) and strategy two (S_2), or strategy two (S_2) and strategy three (S_3), or strategy three (S_3) and strategy one (S_1). This in turn explains that the relative effectiveness of all the three instructional strategies is the same in terms of the achievement of the instructional objectives for the students of low level of intelligence.

Therefore the null hypothesis 2c that there will be no significant difference in the achievement of the instructional objectives among the students of low level of intelligence when taught through either strategy one (S_1) and strategy two (S_2), or strategy two (S_2) and strategy three (S_3), or strategy three (S_3) and strategy one (S_1) is not rejected.

This establishes that the knowledge can be achieved effectively by the students of low level of intelligence irrespective of the strategy (out of the three strategies included in the experiment) they are taught through.

PART II

The second phase of the experiment as stated earlier, also includes the same statistical technique i.e. the analysis of variance for the randomized group design when data were analyzed for each instructional strategy separately to study differences between groups of the students of three levels of intelligence, viz. high level, average level and low level of intelligence. This part II of the analysis tested the hypotheses 3a, 3b and 3c.

ANALYSIS OF VARIANCE FOR THE RANDOMIZED GROUP DESIGN
(for each strategy separately)

(d) R.G.D. for Strategy One (S_1) :

To test the hypothesis 3a that there will be no signifi- cant difference in the achievement of the instructional

objectives between the students of high and average level of intelligence or average and low level of intelligence, or high and low level of intelligence, when taught through strategy one (S_1), the scores for all the three criterion tests for all the three corresponding units which were taught through only strategy one (S_1) were recorded for the students of each level of intelligence separately. The same scores recorded intelligence level-wise, were added up separately for each level of intelligence. Also the individual original score was squared up and the total of the squared up scores was also done. The same is presented in the table below.

Table 22 : Scores achieved by the students of high, average and low level of intelligence when taught through strategy one (S_1).

High Level of Intelligence			Average Level of Intelligence			Low Level of Intelligence		
Sr. No.	Original Score	Square	Sr. No.	Original Score	Square	Sr. No.	Original Score	Square
1	21	441	1	18	324	1	19	289
2	24	576	2	15	225	2	14	196
3	24	576	3	22	484	3	23	529
4	23	529	4	21	441	4	15	225
5	20	400	5	19	361	5	15	225
6	25	625	6	19	361	6	19	361
7	24	576	7	22	484	7	19	361
8	18	324	8	18	324	8	20	400
9	24	576	9	16	256	9	18	324
10	24	576	10	21	441	10	20	400

1 8 0

Table 22 (contd..)

High Level of Intelligence			Average Level of Intelligence			Low Level of Intelligence		
Sr. No.	Original Score	Square	Sr. No.	Original Score	Square	Sr. No.	Original Score	Square
11	19	361	11	21	441	11	24	576
12	23	529	12	15	225	12	22	484
13	23	529	13	22	484	13	07	049
14	22	484	14	16	256	14	06	036
15	23	529	15	18	324	15	21	441
16	16	256	16	10	100	16	17	289
17	14	196	17	18	324	17	19	361
18	14	196	18	23	529	18	24	576
19	13	169	19	24	576	19	16	256
20	08	064	20	24	576	20	18	324
21	17	289	21	23	529	21	16	256
22	11	121	22	21	441	22	13	169
23	17	289	23	20	400	23	19	361
24	25	625	24	24	576	24	15	225
25	19	361	25	22	484	25	22	484
26	23	529	26	21	441	26	13	169
27	20	400	27	19	361	27	11	121
28	19	361	28	15	225			
29	14	196	29	10	100			
30	23	529	20	13	169			
31	21	441	31	18	324			
			32	22	484			
			33	14	196			

Table 22 (contd..)

High Level of Intelligence			Average Level of Intelligence			Low Level of Intelligence		
Sr. No.	Original Score	Square	Sr. No.	Original Score	Square	Sr. No.	Original Score	Square
			34	24	576			
			35	22	484			
			36	23	529			
			37	23	529			
			38	24	576			
			39	22	484			
			40	12	144			
			41	15	225			
			42	13	169			
			43	10	100			
			44	12	144			
			45	22	484			
			46	14	196			
			47	21	441			
31	611	12653	47	881	17347	27	465	8559

The same data were then analysed applying the analysis of variance.

The necessary detailed steps calculated for the F ratio are as follows:

$$N ' = 105$$

$$\leqslant X = 611 + 881 + 465$$

$$= 1957$$

$$(\leq X)^2 = 3829849$$

$$.C = \frac{(\leq X)^2}{N}$$

$$= \frac{3829849}{105}$$

$$= 36474.752$$

$$\leq X^2 = 12653 + 17347 + 8559$$

$$= 38559$$

$$SS_T = \leq X^2 - C$$

$$= 38559 - 36474.752$$

$$= 2084.248$$

$$SS_B = \frac{(\leq H)^2}{31} + \frac{(\leq A)^2}{47} + \frac{(\leq L)^2}{27} - C$$

$$= \frac{(611)^2}{31} + \frac{(881)^2}{47} + \frac{(465)^2}{27} - 36474.752$$

$$= \frac{373321}{31} + \frac{776161}{47} + \frac{216225}{27} - 36474.752$$

$$= 12042.612 + 16514.063 + 8008.333 - 36474.752$$

$$= 36565.008 - 36474.752$$

$$= 90.256$$

$$SS_W = SS_T - SS_B$$

$$= 2084.248 - 90.256$$

$$= 1993.992$$

Thus,

The sum of squares between the cells = 90.256

The sum of squares within the cells = 1993.992

The following table gives the summary of the results of

analysis of variance, on the data treated under randomized

group design for the performance of the students of all the three specified levels of intelligence, taught through the strategy one (S_1).

Table 23 : The summary of Results of Analysis of Variance on the Data treated by Randomized group Design for the performance of the students of all the three specified levels of Intelligence taught through the strategy one (S_1)

Source of variance	df	SS	MS	F ratio	Level of Significance
SS_B (Intelligence)	2	90.256	45.128	2.308	NS
SS_W (Error)	102	1993.992	19.55		
	104				

The above table shows that the F ratio for the groups of intelligence viz. 2.308 for df 2/102 is not significant at 0.01 level of significance. This means that there are no differences in the achievement of the instructional objectives by the students of all the three levels of intelligence when taught through the strategy one (S_1). This means that the relative effectiveness of the strategy one (S_1) is the same in terms of the achievement of the instructional objectives, for all the students of the three specified levels of intelligence.

Therefore the null hypothesis 3a that there will be no significant differences in the achievement of the instructional objectives between the students of high and average

level of intelligence, or average and low level of intelligence, or high and low level of intelligence when taught through the strategy one (S_1), is not rejected.

This finalizes that the strategy one (S_1) has been effectively used for the achievement of knowledge by all the students irrespective of their intelligence level.

(e) R.G.D. for the Strategy two (S_2)

To test the hypothesis 3b that there will be no significant difference in the achievement of the instructional objectives between the students of high and average level of intelligence or average and low level of intelligence or high and low level of intelligence when taught through the strategy two (S_2) the scores for all the three criterion tests for all the three corresponding units which were taught through only the strategy two (S_2) were recorded for the students of each level of intelligence separately. The same scores recorded intelligence level-wise were added up separately for each level of intelligence. Also the individual original score was squared up and the total of the squared up scores was also done. The same is presented in the table below.

Table 24 : Scores achieved by the students of high, average and low level of intelligence when taught through strategy two (S_2)

High Level of Intelligence			Average Level of Intelligence			Low Level of Intelligence		
Sr. No.	Original Score	Square	Sr. No.	Original Score	Square	Sr. No.	Original Score	Square
1	17	289	1	20	400	1	22	484
2	25	625	2	17	289	2	24	576

Table 24 (contd..)

High Level of Intelligence			Average Level of Intelligence			Low Level of Intelligence		
Sr. No.	Original Score	Square	Sr. No.	Original Score	Square	Sr. No.	Original Score	Square
3	17	289	3	13	169	3	19	361
4	17	289	4	17	289	4	10	100
5	20	400	5	23	529	5	05	025
6	12	144	6	22	484	6	17	289
7	14	196	7	23	529	7	16	256
8	16	256	8	19	361	8	19	361
9	21	441	9	18	324	9	20	400
10	07	049	10	22	484	10	14	196
11	20	400	11	17	289	11	17	289
12	18	324	12	20	400	12	15	225
13	17	289	13	21	441	13	18	324
14	24	576	14	14	196	14	21	441
15	23	529	15	16	256	15	15	225
16	15	225	16	12	144	16	19	361
17	24	576	17	14	196	17	12	144
18	22	484	18	20	400	18	12	144
19	19	361	19	20	400	19	16	256
20	24	576	20	07	049	20	15	225
21	24	576	21	21	441	21	24	576
22	21	441	22	17	289	22	18	169
23	17	289	23	21	441	23	08	064
24	20	400	24	25	625	24	22	484
25	25	625	25	16	256	25	19	361

Table 24 (contd..)

High Level of Intelligence			Average Level of Intelligence			Low Level of Intelligence		
Sr. No.	Original Score	Square	Sr. No.	Original Score	Square	Sr. No.	Original Score	Square
26	18	324	26	15	225	26	19	361
27	21	441	27	11	121	27	15	225
28	17	289	28	23	529			
29	21	441	29	15	225			
30	25	625	30	12	144			
31	22	484	31	08	064			
			32	19	361			
			33	13	169			
			34	15	225			
			35	14	196			
			36	18	324			
			37	19	361			
			38	17	289			
			39	17	289			
			40	18	324			
			41	19	361			
			42	13	169			
			43	12	144			
			44	15	225			
			45	17	289			
			46	17	289			
			47	11	121			
31	603	12253	47	793	14125	27	446	7922

The same data were then analysed applying the analysis of variance.

The necessary detailed steps calculated for the F ratio are as follows:

$$N = 105$$

$$\leq X = 603 + 793 + 446$$

$$\leq X = 1842$$

$$\therefore (\leq X)^2 = 3392964$$

$$C = \frac{(\leq X)^2}{N}$$

$$= \frac{3392964}{105}$$

$$= 32313.942$$

$$\leq X^2 = 12253 + 14125 + 7922$$

$$= 34300$$

$$SS_T = \leq X^2 - C$$

$$= 34300 - 32313.942$$

$$= 1986.058$$

$$SS_B = \frac{(\leq H)^2}{31} + \frac{(\leq A)^2}{47} + \frac{(\leq L)^2}{27} - C$$

$$= \frac{(603)^2}{31} + \frac{(793)^2}{47} + \frac{(446)^2}{27} - 32313.942$$

$$= \frac{363609}{31} + \frac{628849}{47} + \frac{198916}{27} - 32313.942$$

$$= 11729.322 + 13379.765 + 7367.259 - 32313.941$$

$$= 32476.346 - 32313.941$$

$$= 162.404$$

$$SS_W = SS_T - SS_B$$

$$= 1986.758 - 162.404$$

$$= 1823.654$$

Thus,

The sum of squares between the cells   = 162.404

The sum of squares within the cells   = 1823.654

The following table gives the summary of the results of analysis of variance on the data treated under randomized group design for the performance of all the three specified levels of intelligence taught through the strategy two (S$_2$).

Table 25 : The Summary of Results of Analysis of Variance on the Data treated by Randomized group design for the performance of the Students of all the three specified levels of intelligence taught through the strategy two (S$_2$)

Source of variance	df	SS	MS	F ratio	Level of Significance
SS$_B$ (Intelligence)	2	162.404	81.202	4.54	0.05
SS$_W$ (Error)	102	1823.654	17.88		
Total	104	1986.058			

The above table reflects that the F ratio for the groups of intelligence viz. 4.54 for df 2/102 is significant at 0.05 level of significance. This means that there are differences in the achievement of instructional objectives amongst the students of different levels of intelligence when taught through the strategy two (S$_2$). This means that the relative effectiveness of the strategy two (S$_2$) is not the same in terms of the achievement of the instructional objectives, for all the students of the three specified levels of intelligence.

Therefore the null hypothesis 3b, that there will be no significant difference in the achievement of the instructional objectives between the students of high and average level of intelligence, or average and low level of intelligence or high and low level of intelligence when taught through strategy two (S_2) is rejected at .05 level of significance.

This leads to a conclusion that there are significant differences (F ratio 4.54 being significant at .05 level) amongst the students of different intelligence groups when they are taught through the strategy two (S_2) as seen from the Table 25. Students of high intelligence group gain the maximum (Mean being 19.45) and the students of low intelligence group gain the least (Mean being 16.52) when taught through strategy two (S_2). This to some extent confirms the results obtained earlier while analysing the data by Latin Square design.

(f) R.G.D. for Strategy Three (S_3)

To test the hypothesis 3c that there will be no significant difference in the achievement of the instructional objectives between the students of high and average level of intelligence, or average and low level of intelligence or high and low level of intelligence when taught through strategy three (S_3), the scores for all the three criterion tests for all the three corresponding units which were taught through only the strategy three (S_3), were recorded for the

students of each level of intelligence separately. The same scores recorded intelligence level-wise were added up separately for each level of intelligence. Also the individual original score was squared up and the total of the squared up scores was also done. The same is presented below in the table.

Table 26 : Scores achieved by the Students of high, average and low level of intelligence when taught through strategy three (S_3)

High Level of Intelligence			Average Level of Intelligence			Low Level of Intelligence		
Sr. No.	Original Score	Square	Sr. No.	Original Score	Square	Sr. No.	Original Score	Square
1	19	361	1	23	529	1	22	484
2	25	625	2	18	324	2	14	196
3	16	256	3	24	576	3	21	441
4	20	400	4	20	400	4	17	289
5	24	576	5	24	576	5	16	256
6	23	529	6	24	576	6	21	441
7	15	225	7	15	225	7	18	324
8	24	576	8	20	400	8	20	400
9	16	256	9	20	400	9	20	400
10	17	289	10	23	529	10	19	361
11	25	625	11	17	289	11	19	361
12	20	400	12	20	400	12	13	169
13	25	625	13	13	169	13	23	529
14	12	144	14	21	441	14	15	225
15	22	484	15	17	289	15	17	289
16	24	576	16	22	484	16	23	529

Table 26 (contd..)

High Level of Intelligence			Average Level of Intelligence			Low Level of Intelligence		
Sr. No.	Original Score	Square	Sr. No.	Original Score	Square	Sr. No.	Original Score	Square
17	17	289	17	19	361	17	18	324
18	24	576	18	18	324	18	24	576
19	22	484	19	23	529	19	17	289
20	22	484	20	18	324	20	21	441
21	23	529	21	20	400	21	20	400
22	23	529	22	22	484	22	11	121
23	20	400	23	23	529	23	09	081
24	17	289	24	16	256	24	02	004
25	12	144	25	13	169	25	20	400
26	14	196	26	14	196	26	07	049
27	15	225	27	19	361	27	14	196
28	11	121	28	18	364			
29	05	025	29	21	441			
30	16	256	30	13	169			
31	11	121	31	15	225			
			32	12	144			
			33	22	484			
			34	23	529			
			35	23	529			
			36	19	361			
			37	17	289			
			38	16	256			
			39	20	400			

Table 26 (contd..)

High Level of Intelligence			Average Level of Intelligence			Low Level of Intelligence		
Sr. No.	Original Score	Square	Sr. No.	Original Score	Square	Sr. No.	Original Score	Square
			40	24	576			
			41	20	400			
			42	22	484			
			43	09	081			
			44	14	196			
			45	05	025			
			46	09	081			
			47	13	169			
31	579	11615	47	861	16703	27	461	8575

The same data were then analysed using analysis of variance.

The necessary detailed steps calculated for the F ratio are as follows:

$$\leqslant X \;=\; 579 + 861 + 461$$

$$=\; 1901$$

$$\therefore (\leqslant X)^2 =\; 3613801$$

$$C \;=\; \frac{(\leqslant X)^2}{N}$$

$$=\; \frac{3613801}{105}$$

$$=\; 34417.152$$

$$\leq X^2 = 11615 + 16703 + 8575$$

$$= 36893$$

$$SS_T = \leq X^2 - C$$

$$= 36893 - 34417.152$$

$$= 2475.848$$

$$SS_B = \frac{(\leq H)^2}{31} + \frac{(\leq A)^2}{47} + \frac{(\leq L)^2}{27} - C$$

$$= \frac{(579)^2}{31} + \frac{(861)^2}{47} + \frac{(461)^2}{27} - C$$

$$= \frac{335241}{31} + \frac{741321}{47} + \frac{212521}{27} - C$$

$$= 10814.225 + 15772.787 + 787.148 - C$$

$$= 34458.16 - 34417.152$$

$$= 41.008$$

$$SS_w = SS_T - SS_B$$

$$SS_w = 2475.848 - 41.008$$

$$= 2434.84$$

Thus,

The sum of squares between the cells $= 41.008$

The sum of squares within the cells $= 2434.84$

The following table gives the summary of the results of analysis of variance, on the data treated under randomized group design for the performance of all the three specified levels of intelligence taught through the strategy S_3.

Table 27 : The Summary of Results of Analysis
of Variance on the Data treated by
Randomized Group Design for the
performance of the Students of all
the three specified levels of
Intelligence taught through the
Strategy three (S_3)

Source of variance	df	SS	MS	F ratio	Level of Significance
SS_B (Inelligence)	2	41.008	20.504	0.859	NS
SS_W (Error)	102	2434.84	23.871		
Total	104	2475.848			

As can be read from the above table the F ratio for

the groups of intelligence viz. 0.859 for df 2/102 is not

significant at 0.01 level of significance. This means that

there are no differences in the achievement of the instru-

ctional objectives by the students of all the three levels

of intelligence, when taught through the strategy three

(S_3). This means that the relative effectiveness of the

strategy three (S_3) is the same in terms of the achievement

of the instructional objectives for all the students of the

three specified levels of intelligence.

Therefore the null hypothesis 3c that there will be

no significant difference in the achievement of the instru-

ctional objectives between the students of high and average
                              average and low level of intelligence
level of intelligence or high and low level of intelligence

is accepted.

It may be noted that besides the two designs, i.e.
(i) Latin Square design and (ii) Randomized Group design
even the third design namely Randomized Block design was also
employed to confirm the same results. But the calculations
and the tables pertaining to Randomized Block design are not
presented in this chapter as it was revealed through analysis,
that conclusions remain almost the same, i.e. instructional
strategies as such make no difference, and that level of
intelligence is a significant factor in case of strategy two
(S_2) (high intelligence group gain the most from strategy two
(s_2)). However the same data cannot be fundamentally analysed
with a Factorial design procedure, to confirm the same results
because the same groups of subjects were assigned to each of
the three instructional strategies (not orthogonal but related).
In case, if each group consisted of independentally different
subjects, in each sub group (cell), data could have been
analysed, as if in a Factorial design, but it is not authorized
here and hence the same design was not used to confirm the
same results.

Findings :

As a result of the experiment the following findings
were arrived at.

1. There is significant difference between the instructional
   strategy one (S_1) and strategy two (S_2) in their effecti-
   veness in terms of the achievement of the instructional
   objectives. To be specific strategy one (S_1) is found to
   be better than strategy two (S_2) only in case of learning

unit one and not in case of learning unit two and three.

2. There is no significant difference between the instructional strategy two (S_2) and three (S_3) in their effectiveness in terms of the achievement of the instructional objectives.

3. There is no significant difference between the instructional strategy one (S_1) and three (S_3) in their effectiveness in terms of the achievement of the instructional objectives.

4. There is no significant difference in the achievement of instructional objectives by the students of high, or average or low level of intelligence when each was separately taught through either strategy one (S_1) and strategy two (S_2), or strategy two (S_2) and strategy three (S_3) or strategy one (S_1) and strategy three (S_3).

5. There is no significant difference in achievement of the instructional objectives between the students of high and average level of intelligence or average and low level of intelligence, or high and low level of intelligence when taught through strategy one (S_1).

6. There are significant differences in the achievement of instructional objectives among the students belonging to different levels of intelligence, when taught through strategy two (S_2). To be specific the students of high level of intelligence gained maximum whereas the students of low level of intelligence gained the least when taught through strategy two (S_2).

7. There is no significant difference in the achievement of the instructional objectives between the students of high and average level of intelligence, average and low level of intelligence, or high and low level of intelligence when taught through strategy (S_3).

In short, strategy one (S_1) including PIM + Laboratory demonstrations + Discussion was found to be better in learning only one unit on 'proteins' and not in case of learning other two units, namely 'carbohydrates' and 'fats', i.e. all strategies are equally effective in teaching the selected content. Further strategy two (S_2) is found to be more effective only with the high intelligence group, with other two strategies level of intelligence played no significant role.

DISCUSSION OF THE RESULTS (Findings)

From the results of the first phase of the analysis which includes testing of the hypotheses 1a, 1b and 1c, it can be seen that the null hypotheses 1b and 1c could not be rejected, only the null hypotheses 1a could be rejected. Rejection of the hypotheses 1a clearly showed that the instructional strategy one (S_1) viz. PIM + Laboratory demonstration + Discussion differed from strategy two (S_2) viz. structured lecture with blackboard work + laboratory demonstration + library reference work, in its effectiveness in terms of achievement of the instructional objectives as measured by the criterion tests administered.

However results seem to show the superiority of strategy one (S_1) over the strategy two (S_2). This may be due to the reason that strategy one (S_1) includes PLM coupled with laboratory demonstration and discussion.

It has been usually believed that teaching through PLM has only benefitted the school pupils and has failed to motivate the learning process at college level. But in the present study it has been disclosed that it has worked wonders with the college students in acquiring maximum learning. This may be because PLM was used with the other teaching techniques, viz. laboratory demonstration and discussion. The finding agrees with Leith, (1966) who has emphasized that PLM would be more effective only when it is used as a part of the instructional process, along with the other teaching techniques.

Speaking in terms of the positive effects produced by a combination of teaching methods this shows that learning through auto-instructional, ready programmed material taught with other teaching techniques is significantly superior to an instructional situation in case of strategy two (S_2), where the practising teacher herself communicates the content matter through structured lectures making maximum use of the blackboard work; along with the other teaching techniques, namely, laboratory demonstration and library reference work. Some of the other possible reasons which can perhaps be accounted for the finding in favour of the

strategy one (S_1) are; (i) PLM allows self pace and has a great scope of referability; and (ii) students also have the advantage of having the complete content matter with them which in turn would help them to learn and revise with self confidence. Besides the students had undergone a detailed practice of answering the questions asked in the programmed matter when they had to solve the same in the class-room. Moreover the programmed instruction being not very common in India, specially at college level, the students might have been motivated undergoing perhaps their first exposure to this sort of instruction. Thus it is the element of novelty that might be in the play here, which has encouraged students to fair well, when taught through strategy one (S_1). This can perhaps account for the superiority of strategy one (S_1) in terms of students' achievement. However it may be noticed that, although strategy one (S_1) differed from strategy two (S_2), the results of the Least Significant Difference test revealed that strategy one (S_1) was superior to strategy two (S_2), only in case of learning unit one (U_1) and not Unit two (U_2) and Unit three (U_3).

Further, on accepting the hypotheses 1b, it was proved that instructional strategies, namely, strategy (S_2) viz. 'structured lecture with black-board work + laboratory demonstration + library reference work' and the strategy three (S_3) viz. 'Taped commentary with charts and worksheets

+ laboratory demonstrations + Discussion, were found to be equally effective in terms of achievement of the instructional objectives as measured by the criterion tests.

The equivalence in the effectiveness of the strategy two (S_2) and three (S_3) can be mostly due to the factors such as (i) the teaching lessons were not only planned and organized by the practising teacher i.e. the investigator herself but they were also delivered by the investigator in case of strategy two (S_2) and tape recorded in the voice of investigator herself to be used in the strategy three (S_3). Moreover, she herself operated the tap-recorder too. Thus the communicator was physically present in case of communication through both the strategies. Besides, the slow simple language, taped presentation would have facilitated the notes-taking as it would have been in case of learning through listening to lecture. Big colourful charts, bearing realistic drawings and written facts would have also enabled the students to understand the content equally well as in case of strategy two (S_2) in which black-board was used to the maximum, for the same purpose.

Further, on rejecting the hypothesis 1c, it was found that strategy one (S_1) and strategy three (S_3) were similar in efficiency in terms of achievement of the instructional objectives as measured by the criterion tests administered. This may be because of the reason that just as in strategy one (S_1) the students got the practice of solving questions

in the programmed material, they had to undergo the same for

solving the sets of questions in the work-sheets after

listening to the learning matter through a tape-recorder.

It may be noted that like PLM, work-sheets also remained with

the students which helped them to revise the subject matter

before attempting the criterion test. Besides this the

students had the advantage of laboratory demonstrations as

well as discussion, while learning through these two strate-

gies. It may be noted that most of the time students mastered

the facts through self efforts while learning through strategy

one (S_1) and three (S_3) as these included PLM and taped

commentary respectively. These were the reasons which could

have perhaps accounted for the equivalence in efficiency of

both these strategies.

The same results might have not been procured, if some

other teacher might have lended her voice for tape-recording

the content matter, or if the charts and work-sheets were

omitted from the strategy three (S_3). Even if the black-

board work was deleted and the other components were

excluded from the strategy two (S_2), the investigator would

have arrived at different findings.

From the results of the second phase (part 1) of the

analysis, which includes testing of the hypotheses 2a, 2b

and 2c, it can be seen that all these three null hypotheses

were accepted. This means that when data were analysed for

each level of intelligence separately it was established that

there were no significant differences found amongst the
students of high, average as well as low intelligence level
while learning through any of the three strategies. However
it is widely accepted that intelligence is the major factor,
contributing to the academic achievement. But in this case
it could be believed that carefully structured sequence of
an instructional material, taught through an adequate
combination of teaching techniques would help to iron out
the effect of intelligence on the achievement of the students.
Speaking frankly, in the present study the three instructional
strategies each composed of a combination of useful teaching
techniques have been evolved by an experienced practising
teaching who had taken care to make a well sequenced easily
understandable content matter to be presented through the
efficient teaching techniques.

From the results of the second phase (part II) of the
analysis, which includes testing of the hypotheses 3a, 3b
and 3c, it can be seen that the hypotheses 3a and 3c were
accepted while the hypothesis 3b was rejected. Accepting
the hypotheses 3a and 3c, it was revealed that there were
no significant differences amongst the students of high,
average and low level of intelligence when they were taught
through either strategy one (S_1) or strategy three (S_3) but
rejection of hypoghesis 3b showed that there were significant
differences amongst the students of dif*rent intelligence
groups, when they were taught through strategy two (S_2).

To be specific, the students of high intelligence group gained the maximum whereas the students of low intelligence group gained the minimum. This could have been due to the reason that low achievers must have found it difficult to grasp the content taught through the structured lectures and they may also not have found it interesting to study through library reference work. However the results of the present study do show a ray of hope even for the low achievers who normally lag behind in a class where the teacher teaches in a conventional way.

In short, the best ultimate output depends upon the best input which comprises of two main ingredients, that is, the teacher should have through detailed knowledge of the area as well as the skills in educational techniques which act as catalysts enhancing the effective learning process. "One of the basic truths", says Kochhar (1967) "in education is that, quality of education depends upon the quality of teacher. Only an experienced, and efficient teacher who is sincere in her profession, can develop best suitable strategies for her student population of varying intelligence."

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