CHAPTER - VI

DISCUSSION OF RESULTS AND GENERALIZATIONS
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The last chapter deals with interpretation of the results of the experiment with the help of appropriate statistical techniques. The conclusions drawn on the basis of analysis attempted there, are discussed in this chapter.

The experiment was conducted on the basis of 2x2x2x2 factorial design. The different factors were: instructional design, intelligence, self-concept and n-Achievement, which were studied as independent variables and the performance of the students was studied as dependent variable.

The main effects of the study were varied at two levels each. There were two levels of instructional design (D₁ - Programmed instruction; D₂ - Adjunct Programming), two levels of intelligence (I₁ - High intelligence, I₂ - Low intelligence), two levels of n-Achievement (A₁ - High achievement motivation and A₂ - Low achievement motivation), self concept (S₁ - High self-concept and S₂ - Low self-concept). The interaction effects of these variables were analyzed by the 4-way analysis of variance.

The following conclusions regarding the main effects and interaction effects were drawn:

6.1 MAIN EFFECTS:

The F-ratio for the main effect of instructional
design was calculated to be 75.176 for 1/176 df. It was found to be significant at .01 level of confidence. The significant F-ratio led us to the conclusion that difference between the effects of two levels of instructional design viz. Programmed instruction and Adjunct-Programming is highly significant, implying retention of the hypothesis in this case which states that, "Programmed instruction will yield better results than adjunct-programming with regard to the students' performance on the criterion test". The significant mean square of this factor forms the basis of the assertion that means for two levels differ significantly from each other. The mean for Programmed Instruction \(D_1\) is 76.56, whereas the mean for Adjunct Programming \(D_2\) is 68.47. An examination of two means shows that Programmed instruction is a better level of instructional design as compared to Adjunct-programming.

The superiority of Programmed instruction as found in the present study is in agreement with the findings of Hughes and McNamara (1961), Ripple (1963), Holt (1963), Sharma (1965), Mullick (1968), Jean (1977), Gupta & Gupta (1979), Leone (1980) and Waters (1981). Gupta (1983) conducted a study on low achievers and found that experimental group being taught by Programmed instruction was superior to a group taught by conventional method both in terms of
retention and amount learnt. Leane (1980) taught 160 students through Programmed instruction and 80 students through conventional classroom methods. He found that the group taught by Programmed instruction learnt more than 80% of the material and had significantly higher gain scores than those of the group taught by conventional methods.

Cokwood (1980) compared the achievement of three groups; one taught by Traditional instruction assisted by computer instruction, another group by Traditional instruction supplemented by Programmed instruction and the third group by Traditional lecture/Text book approach. His findings could not support definitely as to which of the three methods employed was the most effective.

Yassin (1980) found combination method combining Programmed instruction and Traditional method to be superior to both Traditional method and Programmed instruction.

Baselman (1974) developed a linear programme made up of 300 units covering mathematics. Traditional teaching was maintained as well. He found advantages of doing so in diagnostic and remedial teaching. Saini (1978) reported the significantly superior performance of students taught by Programmed Text over the ones who learnt through the Text Book.

The F-ratio for main effect of I (intelligence) was found to be 1087.1, which is significant at .01 level of
confidence. Thus it can be inferred that intelligence affects the performance of the subjects. A comparison of the means of high (I₁) and low (I₂) intelligence groups showed that I₁ group scored significantly more than I₂ group. Thus, the hypothesis that, "the performance of high intelligence group will be significantly better than that of low intelligence group", is retained.

This finding is supported by numerous studies, which found learning to be significantly related to intelligence when the mode of instruction was Programmed text. Lambert, Miller and Wiley (1962) in a programme with 800 frames found that learning was significantly associated with intelligence. Tuel (1963) found that more intelligent subjects retained significantly more than less intelligent subjects.

Underwood (1954), Alter (1963) and Morris et al (1970) found that the low ability students took more time to complete a given self-paced programme than the high ability subjects. Evans (1963) found significant differences in terms of error rate and criterion test scores of the students belonging to three different intelligence groups. Intelligence was reported to be related positively to criterion test scores and negatively to error rate. Jensen (1963) comparing school children classified as "educationally mentally retarded", 'average' and 'gifted' obtained similar
results with his very wide range of I.Q. scores, on a
selective learning task that involved learning by trial and
error to associate five or six different responses. Variability
was much greater amongst the retarded children.

Studies by Cresswell (1964) and Larkin and Leith
(1964) similarly showed a significant effect of intelligence
on learning, when programmed instruction was employed to
teach the students. Larkin (1964) found that group
differences in learning, which appeared to favour the higher
ability groups, only did so, when the post-test was delayed.

Lewis and Gregson (1965) with a sample of restricted
I.Q. range (80-115) found the effect of intelligence on both
immediate and retained learning to be highly significant.
Filep (1966) obtained a positive correlation between learning
and I.Q.

Snow (1969) discovered interaction of ability and
programme method while experimenting with twelfth grade
students. He concluded that phonic method of instruction
appeared more appropriate for low ability students and
students with higher ability, learnt better with 'look and
say' system. Major (1970) also reported a positive
correlation between intelligence and final test scores,
using two versions of programme on mathematics found that high
ability students performed better than low ability students on both the versions of the programme. It was also found that low ability students took more time to complete the programme.


The results of all the studies mentioned above, fall in line with the finding obtained from the present investigation. However, there have been a few studies which did not find any relationship between the two variables. Porter (1959) used machines to teach spellings and failed to find any significant relationship between factors of intelligence and achievement. Stoulrow (1962) also found the same results while using self-instructional material for teaching logic, mathematics and statistics. These contradictory results might have been reached due to differences in sample structure or different experimental conditions.

Coming to the main effect of S (Self-concept), the F-ratio for it was found to be 206.39 for df 1/176. It is
significant at .01 level of confidence. It may, therefore, be stated that there is significant difference between the mean achievement scores of high self-concept subjects and those of low self-concept subjects. The hypothesis that "High self-concept students will perform significantly better than students with low self-concept", is, hence, accepted. The mean for the High self-concept group ($X_1$) was found to be 79.18 and for the low self-concept group it was calculated to be 65.86. After examining the two means, it can be stated that the high self-concept subjects were found to be superior to low self-concept subjects as far as their performance on the criterion test was concerned.

These results seem to be in agreement with the results of Brookover, Thomas & Patterson (1964), who after studying 1050 students of Class VIII found a significant positive relationship between self-concept and performance. They discovered that this relationship was substantial even when I.Q. was controlled. Mayer (1981) found significant correlation between achievement and self-concept when individualized instruction programme was used to teach the students. Lewis and Adank (1975) conducted a study on class 4, 5 and 6 students and reported a significant positive interrelationship between achievement and variable of self-concept. Jacobowitz (1980) found a moderate

Results of researches of Mitchell (1959), Peters (1968), Morakinyo (1970), Neighan (1970), Byron (1976), Cotton (1980), Morford (1980), Smith (1982), Baughman (1982) and McGlynn (1983), are at variance with the findings of the present investigation. The variations may be contributed to the qualitative and quantitative differentia of the sample along with the differences in nature of the subject studied by these investigators.

The main effect of the factor related to n-Achievement was found to be 562.26 for df 1/176. This F-ratio was found to be significant at .01 level of confidence. It may, thus, be inferred that difference between treatment effects of two levels of n-Ach was significant. The difference between the means of high n-Ach and low n-Ach was calculated to be 21.81 in favour of high n-Ach group which forms the basis for the conclusion that high n-Ach students score significantly higher than the subjects with low n-Ach. This conclusion leads to the
retention of the hypothesis that "Students with high n-Achievement will achieve higher on the criterion test, than those with low n-Achievement".

Atkin and Litwin (1960) reported a positive correlation between n-Ach and performance in examination. Razzilli (1980) conducted a study to examine the relation between total motivation to achieve and school scores. The statistical significance of the achievement group variable indicated that overachievers had higher total motivation scores than underachievers. That n-Ach affects performance of the students was reported by independent studies done by Irvin (1967), Davide (1966), Bhatnagar (1966), Ringnes (1967), Entwistle & Welsh (1969), Mohta (1973), Sabharwal (1973), Mallik (1977), Crawford (1978), Gordon (1981) and Barki (1982). These results lend support to the findings of the present study.

Broverman et al (1960), Smith (1964), Dotty and Dotty (1966), Girija et al (1975) and Margol (1980), as a result of their independent studies, reported either negative or no correlation between these two variables. The contradictions in the results of these studies with the findings of the present study, might be due to different tasks taken by them in their studies.
Interaction Effects

The interaction effects of DxS (Instructional design and self-concept), DxA (Instructional design and n-Achievement), DxA (Instructional design and Intelligence), IxA (Intelligence and n-Achievement), IxS (Intelligence and self-concept), AxS (n-Achievement and self-concept), DxAxI (Instructional design, n-Achievement and Intelligence), DxAxS (Instructional design, n-Achievement and self-concept), DxIxS (Instructional design, Intelligence and self-concept), IxAxS (Intelligence, n-Achievement and self-concept) and AxIxDxS (n-Achievement, Intelligence, instructional design and self-concept) were also analyzed by means of analysis of variance technique. Analysis in terms of 't-test' was carried out in case of significant F-ratios.

The DxS interaction indicated a F of 0.106 for 1/176 df, which is not significant even at .05 level of confidence. It means that 'D' effect is independent of 'S', i.e., difference between $D_1$ and $D_2$ is not dependent upon self-concept of the subjects. The DxS interaction is identical with Sx0 interaction and the statement about the difference between $S_1$ and $S_2$ being independent of 'D' is also true. Thus, the conclusion drawn from this discussion is that the treatment effect of both the levels of instructional design is equally effective for $S_1$ and $S_2$ groups of self-concept.
The interaction effect of DXA was also not found to be statistically significant. This points out that the difference between the levels of n-Achievement (High and Low) is independent of levels of 'D'. In other words the difference between $D_1$ and $D_2$ is not dependent upon the factor of n-Achievement.

DxI interaction was found to be non-significant statistically. It indicates that intelligence does not interact with any level of instructional design and vice-versa. This conclusion falls in line with the findings of Janeson et al. (1969) who found no significant relationship between intelligence test scores and instruction via either programmed text, audio visual lectures or straight lectures.

Thus, the fifth hypothesis of the study which states, "The two way interaction between two levels of instructional design and two levels each of intelligence, self-concept and n-Achievement will be significant", stands rejected for all the three interaction viz. DxD, DxI and DXA.

The interaction effect of IXA with a F-ratio of 69.27 was found to be significant at .01 level of significance. So, we conclude that intelligence is not independent of n-Achievement. Similarly, it can be said that levels of n-Achievement are dependent upon the factor of intelligence.

In order to locate the exact nature of interaction,
't' ratios for IxA interaction were calculated. The 't' ratio for this interaction was found to be significant. The difference between $I_1$ and $I_2$ for high level of n-Achievement is significantly more than the same difference for low level of n-Achievement. Similarly, the difference between $A_1$ and $A_2$ for high level of intelligence was significantly more than this difference for low level of intelligence. It may be asserted that high level of n-Achievement interacts significantly with both high and low level of intelligence.

IxS interaction indicated a F-ratio of 118.46 for 1/176 df, which is significant at .01 level of confidence. An analysis in terms of 't'-ratios showed that the variable of self-concept interacted significantly with intelligence, when level of intelligence was high ($I_1$) but failed to produce the same results when low intelligence group ($I_2$) was taken into consideration. Rest of the five 't' values were found to be significant indicating that intelligence interacts significantly with both the levels of self-concept. Our hypothesis that, "Intelligence will interact with self-concept and n-Achievement, each varied at two levels, in two way interaction to produce significant results", is partially retained.

Lewis, John A Adank (1975) found a significant interrelationship among the measures of intelligence,
achievement and self-esteem. Goss, Wooden & Muller (1980) after studying 47 males and 49 females of sixth grade reached the conclusion that self-concept measures reflective of academic success can be combined with intelligence measures to account for substantially greater portions of achievement variance that is possible with the use of intelligence alone. Bhatt (1978) concluded as a result of a study that self-perception and I.Q. tend to show significant interrelationship only when the society is highly discriminative between high and low intelligence subjects. Savicky (1980) found that the higher the I.Q., the more positive is the self-concept and consequently better achievement. However, Riedel (1980) could not find statistically significant relationship between I.Q, scores and scores of self-esteem.

The interaction effect of $A \times S$ was again found to be significant at .01 level of significance. This indicates that levels of $n$-Achievement interact significantly with levels of self-concept. An examination of 't'-ratios shows that self-concept interacts significantly with low level of $n$-Achievement ($A_2$) but not with high level of $n$-Achievement ($A_1$). Thus, the hypothesis that, "Levels of self-concept and $n$-Achievement will interact significantly with each other to affect the performance of the students" is partially retained.
The three-way interaction between AxIxS was found to be highly significant with F-ratio of 183.203. This shows that n-Achievement, intelligence and self-concept interact significantly with each other.

The interactions between AxDxS and IxDxS were found to be non-significant even at .05 level of confidence, with F-ratio of 0.468 and 0.787 respectively. This indicates that n-Achievement x instructional design x self-concept; and intelligence x instructional design x self-concept do not interact significantly with each other in a three-way interaction.

The four way interaction between AxIxDS was also not found to be significant at any level of confidence, with F-ratio less than one. This indicates that n-Achievement, intelligence, instructional design and self-concept do not interact significantly with each other. Thus, the eighth hypothesis of the study that states, "Triple and quadruple interactions of the four variables viz., instructional design, intelligence, self-concept and n-Achievement, will
be significant", is retained for AxIxS interaction and rejected for AxIXD, AxDXS, IxDxS and AxIxDXS interactions.

6.3 GENERALIZATIONS

In view of the foregoing discussion, the following generalizations may be attempted:

- Programmed instruction is more effective for teaching science than Adjunct programming.
- Intelligence affects the performance of the subjects significantly. Performance of high intelligence group is better than that of the low intelligence group.
- The subjects with higher self-concept score higher on the criterion test than subjects with low self-concept.
- The performance of the students with higher n-Ach is significantly superior to that of the ones with low n-Ach.
- There is no significant interaction between levels of instructional design employed and self-concept. It implies that both high and low self-concept subjects will achieve same scores, whatever the level of instructional design may be.
- The interactions between levels of instructional design and n-Achievement and levels of instructional design and intelligence are non-significant.
Intelligence interacts with n-Achievement to significantly affect the performance of the students. In this interactional category high intelligence x high n-Ach (I₁A₁) group achieves more than a group which is low both on intelligence and n-Ach (I₂A₂).

The performance of high and low self-concept students is not independent of their intelligence i.e., intelligence interacts significantly with self-concept. It leads us to the conclusion that students with high intelligence and high self-concept (I₁S₁) score significantly more than students with low intelligence and low self-concept (I₂S₂).

n-Achivement interacts significantly with self-concept to affect the performance of the students. It indicates that A₁S₁ group is significantly better in performance than A₂S₂ group.

The triple interactions between the variables of the study are not significant except for the one between n-Achivement x intelligence x self-concept. The significant AxSxI interaction indicates that the means of IxS interaction
differ at the two levels of n-Ach (A$_1$ & A$_2$); and that value of IxA interaction is different at S$_1$ from the value of the same interaction at S$_2$ level; and that magnitude of SxA interaction differs at the two levels of intelligence (I$_1$ & I$_2$).

- The quadruple interaction between n-Ach x intelligence x instructional design x self-concept is not significant. It can be said that the factor of instructional design is independent of n-Ach, intelligence and self-concept; and that difference between the two levels of n-Ach (A$_1$ & A$_2$) is not dependent upon the factors of intelligence, instructional design and self-concept and that factor of intelligence is independent of other three factors viz. n-Ach, instructional design and self-concept and that difference between S$_1$ and S$_2$ is independent of factors of intelligence, n-Achievement and instructional design.
the performance of the students.
- The triple and quadruple interactions of the four variables viz. instructional design, intelligence, self-concept and n-Achivement will be significant.

7.1.3 Sample
The study comprised the target population of class IX students of High Schools of Chandigarh. The sample was randomly selected from twenty five schools of the city and consisted of 1401 students of both the sexes. On the basis of Kelley's (1939) criterion, subjects were divided into two groups (high and low) each of intelligence, self-concept and n-Ach. The common cases falling into eight different categories formed by different treatment combinations of high and low levels of intelligence, self-concept and n-Ach, were selected for the experiment. Thus, sample at the final stage of experiment consisted of 192 students.

7.1.4 Development of the Criterion Test
A criterion test in simple concepts of 'Micro-organism' with special reference to amoeba was developed and validated keeping in view all the behavioural objectives of the Programmed Text. In final form it consisted of 80 items. The coefficient of reliability of the criterion test was computed by the formula K-R-21. It was found to be .982. The content validity of the criterion test was established by
finding the correspondence between the test items and the behavioural objectives.

7.1.5 Development of the Programmed Text:

A linear programme was developed on 'Micro-organism'. After selecting the topic, objectives in terms of behaviour were formulated unit-wise. On the basis of these objectives, frames of the linear programme were written and edited, for technical accuracy, programme techniques and composition.

The programme was validated against the internal criterion of error rate, programme density, sequence progression and the external criterion of 90/90 standard. The programme was found valid in terms of these criteria. The process of validation was carried out at three stages viz. individual, small and field testing, for each of the criteria mentioned above.

The error-rate of the programme was found unit-wise and also for the whole programme. It varied between .40 and .76 for the different units and for the whole programme, it came to be .69 at the field testing stage. The independent densities for the individual units, as well as a cumulative density for the whole programme were also worked out through TTR and were found to be .26, .35, .32 for the three units respectively and .27 for the whole programme.

The Sequence Progression of the programme studied with the help of Scala-gram revealed that there was definite
indication of increasing errors from high achievers to low achievers, showing thereby a logical connection in terms of performance of the high and low achievers on the criterion test and that there is logical sequence among all the units of the programme.

7.1.6 Development of an Adjunct Programme

An Adjunct-Programme was developed on the same concepts as those of linear programme. A linear style of programme and text-book format were used together to form Adjunct-Programme. The frames used in this were taken as such from Programmed Text. The content, the illustrations and the examples presented in the text-book form were same as those given in programme text. The adjunct text was validated empirically on the performance of students along with their comments and the suggestions of subject matter experts and teachers.

7.1.7 Design of the Study

The present experimental study was conducted on a 2x2x2x2 factorial design. There were four independent variables viz. instructional design, intelligence, self-concept and n-Achievement. Performance of students was studied as dependent variable, upon which the effects of independent variables were studied both in terms of variables taken singly as well as taken together in different combinations to find their double, triple and quadruple interaction effects. All the four independent variables were varied at two levels each. There were two levels of instructional design viz. programmed instruction and adjunct-
programming. The factors of intelligence, self-concept and n-Achievement had two levels each - high and low. Hence the result was 2x2x2x2 factorial design. The lay out of the factorial design has been given in Figure 7.1.

This 2x2x2x2 factorial design resulted into sixteen treatment combinations viz., I₁S₁A₁D₁, I₁S₁A₂D₁, I₁S₂A₂D₁, I₂S₁A₁D₁, I₂S₁A₂D₁, I₂S₂A₂D₁, I₃S₁A₁D₂, I₃S₂A₁D₂, I₃S₂A₂D₂, I₄S₁A₁D₂, I₄S₂A₁D₂, I₄S₂A₂D₂. There were twelve subjects in each experimental group.

7.1.1 Tools:
Following tools were used for the collection of the data:

- Intelligence Test: 'General Mental Ability Test' by Jalota (1972)
- Achievement Motivation Test: 'The Achievement value and Anxiety Inventory' by Mehta (1969).
- Test for self-concept 'P.U.I. Inventory' by Deo (1963).

The following tools were developed by the investigator herself:

- Programmed Text.
- Adjunct Programmed Text.
- Criterion Test.
Intelligence

Self-Concept (S)

n-Achievement (A)

Instructional Design (D)

Figure 7.1
Lay Out of the Factorial Design (2x2x2x2)
7.1.9 Data Collection

The data were collected with the help of tools mentioned above from Class IX students of local schools. Deo’s P.W.L. Inventory for self-concept, Jalota’s Mental Ability Test and Mehta’s AVAI for n-Achievement were administered to a target population of 1401 students. Data, thus collected, were scored with the help of appropriate keys. The population was divided into high and low groups on the basis of intelligence, self-concept and n-Achievement separately. Kelley’s (1939) criterion was used for taking 27 percent top and 27 percent bottom students. Thus three groups, each with two levels; high and low, were formed for intelligence, self-concept and n-Achievement respectively. It resulted into six groups of 378 students each. The common cases falling into eight different treatment combinations resulting from these six groups, viz. I₁S₁A₁, I₁S₂A₁, I₁S₂A₂, I₂S₁A₁, I₂S₁A₂, I₂S₂A₁, I₂S₂A₂, were picked up. Twenty four students were selected from each combination on random basis. Thus 192 subjects (24 x 8) were finally chosen to be taught by the different levels of instructional design. Twelve students out of selected twenty-four from each category were taught by D₁ (Programmed instruction) and other twelve by D₂ (Adjunct programming) level of instructional design. Thus, at the end sixteen groups of twelve students
each received the instruction either through Programmed instruction or Adjunct programming. Criterion test was administered both before and after the students received instruction, as Pre-test and Post-test. Gain scores were found by subtracting pre-test scores from post-test scores.

7.1.10 **Analysis of Data**

The data were analysed with the help of analysis of variance technique to determine the main effects of the four factors viz., intelligence (I), self-concept (S), n-Achievement (A) and instructional design (D) and also their interaction effect on the dependent variable of performance. Table 7.1 gives the summary of Analysis of variance.

**Table 7.1**

**Summary of Analysis of Variance**

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional Design; D</td>
<td>3144.42</td>
<td>1</td>
<td>3144.42</td>
<td>76.172**</td>
</tr>
<tr>
<td>Self-concept; S</td>
<td>8520.04</td>
<td>1</td>
<td>8520.04</td>
<td>206.39**</td>
</tr>
<tr>
<td>n-Achievement; A</td>
<td>23210.13</td>
<td>1</td>
<td>23210.13</td>
<td>562.26**</td>
</tr>
<tr>
<td>Intelligence; I</td>
<td>44988.12</td>
<td>1</td>
<td>44988.12</td>
<td>1087.1**</td>
</tr>
<tr>
<td>Source of Variation</td>
<td>Sum of Squares</td>
<td>df.</td>
<td>Mean Square</td>
<td>F-ratio</td>
</tr>
<tr>
<td>---------------------</td>
<td>----------------</td>
<td>-----</td>
<td>-------------</td>
<td>---------</td>
</tr>
<tr>
<td>INTERACTIONS:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instructional design x Self-concept: DxS</td>
<td>4,380</td>
<td>1</td>
<td>4,380</td>
<td>0.106</td>
</tr>
<tr>
<td>Instructional design x n-Ach: DxA</td>
<td>13,54</td>
<td>1</td>
<td>13.54</td>
<td>0.328</td>
</tr>
<tr>
<td>Instructional design x Intelligence: DxI</td>
<td>23,380</td>
<td>1</td>
<td>23.380</td>
<td>0.566</td>
</tr>
<tr>
<td>Intelligence x n-Ach: IxA</td>
<td>2859.79</td>
<td>1</td>
<td>2859.79</td>
<td>69.275**</td>
</tr>
<tr>
<td>Intelligence x Self-concept: IxS</td>
<td>4890.42</td>
<td>1</td>
<td>4890.42</td>
<td>118.469**</td>
</tr>
<tr>
<td>n-Ach x Self-concept: AxS</td>
<td>4097.75</td>
<td>1</td>
<td>4097.75</td>
<td>99.26**</td>
</tr>
<tr>
<td>n-Ach x Intelligence x Instructional design: AxIxO</td>
<td>37.630</td>
<td>1</td>
<td>37.630</td>
<td>0.911</td>
</tr>
<tr>
<td>n-Ach x Intelligence x Self-concept: AxIxS</td>
<td>7562.63</td>
<td>1</td>
<td>7562.63</td>
<td>185.20**</td>
</tr>
<tr>
<td>n-Ach x Instructional design x Self-concept: AxDxS</td>
<td>19.38</td>
<td>1</td>
<td>19.38</td>
<td>0.466</td>
</tr>
<tr>
<td>Instructional design x Intelligence x Self-concept: DxDxS</td>
<td>32.50</td>
<td>1</td>
<td>32.50</td>
<td>0.787</td>
</tr>
<tr>
<td>Instructional design x Intelligence x n-Ach x Self-concept: AxIxDxS</td>
<td>37.63</td>
<td>1</td>
<td>37.63</td>
<td>0.911</td>
</tr>
<tr>
<td>Errors within the Treatment:</td>
<td>7266.25</td>
<td>176</td>
<td>41.28</td>
<td></td>
</tr>
<tr>
<td>Totals:</td>
<td>106707</td>
<td>191</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**F-Value significant at .01 level of confidence.
A perusal of table 7.1 indicates that main effects of all the four variables viz. instructional design, intelligence, n-Achievement and self-concept are significant at .01 level of significance. It means that all these four factors affect the dependent variable of performance of students significantly.

Table 7.1 further shows that interaction effects of intelligence x n-Achievement, intelligence x self-concept, n-Achievement x self-concept and n-Achievement x intelligence x self-concept are significant at .01 level of significance.

7.2 CONCLUSIONS

Following conclusions were arrived at after the conduct of the experiment and analysis of results. The findings pertain to a segment of Biology at high school levels:

- The two levels of instructional design viz. programmed instruction and adjunct programming differ in their effectiveness with respect to mean gain scores. It may be further specified that programmed instruction was found to be more effective than adjunct programming.
- Intelligence accounts for a substantial amount of variance in the students' criterion test scores. High intelligence students score significantly better than the low intelligence children.
Self-concept of students affects their performance in school. Students with high self-concept achieve significantly more than those with low self-concept.

High on n-Achievement and low on n-Achievement groups differ in their gain scores on the criterion test. High achievement-motivated students gain significantly more than low-achievement motivated students.

Instructional design does not interact with either self-concept or n-Achievement or intelligence of students to cause any variance in their performance.

Intelligence interacts significantly with n-Achievement to affect the mean gain scores of the students on the criterion test. It has been found that the difference between the two groups of intelligence (I₁ and I₂) is significantly more for A₁ level of n-Achievement than the difference between the same groups for A₂ level of n-Achievement.

The factor of intelligence interacts with both high and low levels of self-concept to produce significant difference in the mean gain scores of the students. However, the variable of self-
- The variable of n-Achievement interacts significantly with the factor of self-concept to affect the performance of the students. The students, high both on n-Achievement and self-concept ($A_1S_1$ group) perform significantly better than both $A_2S_1$ and $A_2S_2$ groups.

- An appraisal of triple interaction between n-Achievement, intelligence and instructional design, shows non-significant 'f-ratios'. It indicates that these three variables do not interact with each other to produce significant differences in the mean gain scores of the students.

- The three way interaction between n-Achievement, intelligence and self-concept showed a significant f-ratio. It indicates that there is difference between the means of IxA interaction at the two levels of self-concept. It also leads us to the conclusion that the magnitude of AXS interaction differs at the two levels of intelligence and that mean gain scores of IxS interaction at high level of n-Achievement ($A_1$) are significantly different.
from the means of this interaction at low level of n-Achievement ($A_2$).

- The interaction between the variables of n-Achievement and instructional design is independent of variable of self-concept.

- Instructional design, intelligence and self-concept do not interact with each other in a three-way interaction to produce significant variance in the mean gain scores.

- A perusal of four-way interaction between instructional design, n-Achievement, intelligence and self-concept shows a non-significant *F-ratio*. It indicates that these four factors do not interact with each other to affect the performance of the students.

7.3 LIMITATIONS OF THE STUDY:

The applicability of the generalisations of the present experimental study will be determined by the similarity of the conditions between the populations.

Though the data are collected experimentally and are analysed statistically, certain discrepancies might have crept in during the conduct of the experiment. The difference of experimental conditions during different cycles of the experiment, motivation of the experimental subjects,
environmental factors etc. may have affected the reliability of the results and conclusions. The findings can better be interpreted conservatively by taking into account the sampling errors according to the laws of probability.

7.4 SUGGESTIONS FOR FURTHER RESEARCH:

Some suggestions are made, hereby, with regard to the further possibilities of research in this field.

- A study may be conducted to compare the relative effectiveness of different styles of programming viz. linear, mathematics and branching.

- An experimental study may be designed to investigate the effect of step-size in relation to different styles of programming.

- Variables like creativity, S.E.S. and other personality factors may be taken in combination with the present variables to study their effects on the performance of the students using different instructional designs.

- The present study may be replicated with the programmed material on some topic other than the one used in the present study.