Life is a process of satisfying different types of needs. The causes of dissatisfaction may be within or without the individual. Unsatisfied wants generate problems which are most important for the concerned individual in particular and for the society in general. Man is an organism who is capable of solving problems and mysteries of nature, therefore, he goes on trying to solve the problems. The problem solving strategies have paved the way for all the advancement in Science and Technology.

Problem is a relative concept. What is a problem to one child may not be a problem to his nearest neighbour. Children differ in the amount of information they possess about the facts of a problem, in the extent to which they have faced similar problems and in their motivation for solving problems. According to Brownell (1942) "What seems objectively to be the same situation may constitute for one person a puzzle, for another a problem, and for a third a condition with which he is thoroughly acquainted". Problem solving takes place
as soon as the problem is perceived by the problem solver and is aimed to reach the goal stated by the problem.

Very little research has been done in the field of problem solving to determine the most effective problem solving strategy in developing problem solving ability in Science. Different people think in different ways and there is not always one way or one solution to a problem. The present study is aimed at finding, effect of problem solving strategies, anxiety level, cognitive style and intelligence on problem solving ability.

6.2 **STATEMENT OF THE PROBLEM:**

"The effect of Problem Solving Strategies on Problem Solving ability in Science of High School students in relation to Anxiety level, Cognitive style and Intelligence"

6.3 **RESEARCH QUESTIONS:**

1. Do different strategies of problem solving affect problem solving in science differentially?

2. Will a particular strategy of problem solving favour a particular level of intelligence?

3. Is a particular strategy of problem solving more suited to a particular anxiety level subjects?

4. Is cognitive style of learners related to problem solving ability?
6.4 HYPOTHESES:

The present study was conducted to test the following hypotheses:

1. There will be significant difference in mean scores on problem solving ability in respect of groups trained through different strategies of Problem Solving.

2. There will be no significant difference between mean scores of high and low anxious students.

3. Cognitive style does not significantly affect problem solving ability in Science.

4. Intelligence does not account for differential problem solving ability in Science.

5. The independent variables namely strategies of problem solving, cognitive style, intelligence and anxiety will significantly contribute towards the total variance in problem solving ability.

6.4.1 Interactional Hypotheses:

First Order:

1. There is no significant interaction between intelligence and strategies of problem solving.

2. There is no significant interaction between cognitive style (field-independent-dependent) and strategies of problem solving.
3. There is no significant interaction between anxiety level and strategies of problem solving.

4. There is no significant interaction between intelligence and anxiety level.

5. There is no significant interaction between intelligence and cognitive style (field-independent-dependent).

6. There is no significant interaction between anxiety level and cognitive style (field-independent-dependent).

First Order:

1. There is no significant interaction between cognitive style (field-independent-dependent), intelligence and strategies of problem solving.

2. There is no significant interaction between cognitive style (field-dependent-dependent), anxiety level and strategies of problem solving.

3. There is no significant interaction between intelligence, anxiety level and strategies of problem solving.

Third Order:

There is no significant interaction between cognitive style (field-independent-dependent), intelligence, anxiety level and strategies of problem solving.

6.5 DESIGN OF THE STUDY:

In the present study the pretest-posttest factorial
design $(2 \times 2 \times 2 \times 2)$ has been employed. The independent variables in the study included problem solving strategies, cognitive style, intelligence and anxiety and the criterion variable problem solving ability in Science. The classification variable of cognitive style included two levels field-independent and field-dependent, the variable of intelligence involved two levels of intelligence, high and low, the variable of anxiety included high anxious and low anxious, the treatment variable, problem solving strategies was varied in two ways namely - Training through Focusing strategy (Group $A_1$) and Scanning strategy (Group $A_2$) of thinking in problem solving.

6.6 **SAMPLE**:

For conduct of experiment, a sample of 300 students was raised randomly from X class students. Six schools were selected randomly from Government High/Senior Secondary schools of Chandigarh (U.T.). The average age of the sample was 14-15 years. Another two samples of 100 students each were raised randomly for construction and development of problem solving ability test, and for item analysis.

6.7 **DESCRIPTION OF TOOLS**:

The following tools were used to collect the data:-

*Problem Solving Ability Test (in Science)* was developed and standardized by the investigator to measure problem solving ability in Science subjects.
Group Embedded Figure Test developed by Witkin, Olman and Baskin (1971) and published by Consulting Psychologists Press, Inc., was used to identify cognitive style.

General Mental Ability Test (Revised test (72)) developed and published by S. Jalota (1976) was used to measure intelligence.

Comprehensive Anxiety Test developed by Sinha and Sinha and published by National Psychological Corporation, Agra, was used to determine the level of anxiety.

6.8 DEVELOPING PROBLEM SOLVING ABILITY TEST:

A problem solving ability test was locally developed in different categories to measure classificatory, explanatory, experimental, numerical, symbolic and logical abilities of problem solving. The test was validated at three stages. The final draft of the problem solving ability test consisted of ten items. Items were of multiple choice, completion type, involving mathematical calculations and information processing type. The reliability of test was calculated by test-retest method and was found to be 0.95, and the test, was validated against content validity.

6.9 ANALYSIS OF DATA:

The data was analysed by using descriptive statistics, such as mean, median, standard deviation and skewness and kurtosis. In order to draw statistical inferences, and to test
the hypotheses the analysis of variance (2x2x2x2) through covariance using pre-test scores as covariate was employed. Multiple Regression analysis was also used to interpret the data.

6.10 RESULTS:

The results of Analysis of Co-variance, Analysis and Variance and multiple regression analysis are shown in Tables 6.1, 6.2 and 6.3 respectively.
### TABLE 6.1

**SUMMARY OF ANALYSIS OF COVARIANCE FOR THE TOTAL SAMPLE**

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>df</th>
<th>$SS_x$</th>
<th>$SS_y$</th>
<th>$S(xy)$</th>
<th>$SS_{y,x}$</th>
<th>$MS_{y,x}$</th>
<th>$SD_{y,x}$</th>
<th>F-value</th>
<th>Level of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Among Means</td>
<td>1</td>
<td>720.88</td>
<td>693.99</td>
<td>687.21</td>
<td>39.83</td>
<td>39.83</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within Groups</td>
<td>254</td>
<td>5576.27</td>
<td>5202.03</td>
<td>5346.51</td>
<td>937.53</td>
<td>3.69</td>
<td>1.921</td>
<td>10.79</td>
<td>Significant</td>
</tr>
<tr>
<td>Total</td>
<td>255</td>
<td>6596.85</td>
<td>6496.02</td>
<td>6033.72</td>
<td>977.35</td>
<td></td>
<td></td>
<td></td>
<td>as $1/254$</td>
</tr>
</tbody>
</table>

significant at .01 level = 6.74.

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131
<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F-ratio</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategies (A)</td>
<td>1</td>
<td>12.746</td>
<td>12.746</td>
<td>40.42</td>
<td>Significant at .01</td>
</tr>
<tr>
<td>Cognitive style (B)</td>
<td>1</td>
<td>6.878</td>
<td>6.878</td>
<td>21.844</td>
<td>Significant at .01</td>
</tr>
<tr>
<td>Intelligence (C)</td>
<td>1</td>
<td>19.888</td>
<td>19.888</td>
<td>63.164</td>
<td>Significant at .01</td>
</tr>
<tr>
<td>Anxiety (D)</td>
<td>1</td>
<td>0.048</td>
<td>0.048</td>
<td>0.154</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Strategies x Cognitive Style (AMB)</td>
<td>1</td>
<td>0.183</td>
<td>0.183</td>
<td>0.581</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Strategies x Intelligence (AxC)</td>
<td>1</td>
<td>0.183</td>
<td>0.183</td>
<td>0.581</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Strategies x Anxiety (AxD)</td>
<td>1</td>
<td>0.102</td>
<td>0.102</td>
<td>0.324</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Cognitive style x Intelligence (BxC)</td>
<td>1</td>
<td>0.096</td>
<td>0.096</td>
<td>0.307</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Cognitive style x Anxiety (BxD)</td>
<td>1</td>
<td>0.130</td>
<td>0.130</td>
<td>0.414</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Intelligence x Anxiety (CxD)</td>
<td>1</td>
<td>0.006</td>
<td>0.006</td>
<td>0.019</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Strategies x Cognitive style x Intelligence (AxBxC)</td>
<td>1</td>
<td>0.002</td>
<td>0.002</td>
<td>0.007</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Strategies x Cognitive style x Anxiety (AxBxD)</td>
<td>1</td>
<td>0.213</td>
<td>0.213</td>
<td>0.676</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Strategies x Intelligence x Anxiety (AxCxD)</td>
<td>1</td>
<td>0.048</td>
<td>0.048</td>
<td>0.154</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Cognitive style x Intelligence x Anxiety (BxCxD)</td>
<td>1</td>
<td>0.404</td>
<td>0.404</td>
<td>1.284</td>
<td>Insignificant</td>
</tr>
<tr>
<td>Strategies x Cognitive style x Intelligence x Anxiety (AxBxCxD)</td>
<td>1</td>
<td>0.190</td>
<td>0.190</td>
<td>0.604</td>
<td>Insignificant</td>
</tr>
</tbody>
</table>

*significant at .01 level = 6.74
### TABLE 6.3
Table showing R² values and F ratios for the Total Sample.

<table>
<thead>
<tr>
<th>Variables</th>
<th>R²</th>
<th>R</th>
<th>% variance</th>
<th>F values</th>
<th>Level of significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>R² 1.2</td>
<td>0.1225</td>
<td>0.35</td>
<td>12.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R² 1.23</td>
<td>0.2181</td>
<td>0.46</td>
<td>21.81</td>
<td>30.93*</td>
<td>Significant</td>
</tr>
<tr>
<td>R² 1.234</td>
<td>0.4704</td>
<td>0.63</td>
<td>47.04</td>
<td>120.05*</td>
<td>Significant</td>
</tr>
<tr>
<td>R² 1.2345</td>
<td>0.4713</td>
<td>0.63</td>
<td>47.13</td>
<td>0.42</td>
<td>Insufficient</td>
</tr>
</tbody>
</table>

Significant at .01 level = 6.74*

1. Problem solving ability scores in science  
   (dependent variable).
2. Strategies of problem solving (independent variable)
3. Cognitive style test scores (independent variable)
4. Intelligence test scores (independent variable)
5. Anxiety test scores (independent variable).
On the basis of analysis of data and interpretation of results obtained through ANCOVA and ANOVA, the following conclusions were drawn:

- Thinking strategies for problem solving affected significantly problem solving ability of the problem solvers.

- Focusing strategy of problem solving emerged as a superior strategy to the strategy of Scanning so far as problem solving ability, measured by the test developed by the investigator, was concerned.

- Intelligence of the solver significantly affected the problem solving ability irrespective of the strategies of training.

- A bright child trained in any of the two strategies scored higher marks on problem solving ability test than a least bright student.

- Cognitive style of the learner was also found to be significantly contributing to the variance of problem solving ability scores thereby showing that cognitive style affected problem solving ability irrespective of training strategies.

- The group having field independent cognitive style
scored higher mean than field dependent group on problem solving ability test.

- Anxiety proved to be redundant factor so far as development of problem solving ability was concerned.

- High anxious as well as low anxious groups performed equally well on problem solving ability test.

- The interactional effects, obtained by crossing each independent variable at each level with each level of the other independent variables in the study, yielded non significant results.

From the above it can be concluded that levels of other independent variables, namely, cognitive style, intelligence and anxiety did not show differential problem solving ability with respect to two strategies of teaching.

6.11.2 **CONCLUSIONS DRAWN ON THE BASIS OF MULTIPLE REGRESSION ANALYSIS:**

Multiple regression analysis technique was employed to compute the contribution of each independent variable towards the variance in the criterion variable. The following conclusions were drawn:

- Out of four independent variables, treatment variable as well as two classifying variables namely cognitive style and intelligence were found to contribute significantly
Anxiety did not prove to be an effective variable to bring appreciable changes in the criterion scores.

The treatment variable, that is, the training strategies of problem solving contributed 12.25% of the total variance. The classifying variables namely cognitive style, and intelligence contributed 9.56% and 25.23% respectively of the total variance. All the three variables taken together accounted for 47.04% of the variance.

It can be concluded from above that the variables taken up in the present study accounted for only 47% variance in the criterion variable, whereas 53% of variance remained unexplained. The result pointed out that there were other potential variables for the development of problem-solving ability which were not included in the present study.

6.12 **EDUCATIONAL IMPLICATIONS AND APPLICATIONS OF THE PRESENT STUDY:**

People differ in the way they solve their problems and there is not always one way or one solution to a problem. One should always seek various strategies to reach at the solution. The findings of the present investigation have very important implications for improving the quality of instruction in the subjects of Science at high school stage, because in this study an attempt is made to see the effectiveness of various problem-solving strategies to develop problem-solving ability.
solving ability among students. As intelligence and cognitive style play significant roles in developing the problem solving ability of the learner, the teacher should classify the students into different groups according to their intelligence and cognitive style.

The findings of the study will help the teachers to adjust their strategies of training keeping in view the type of the classes they are to deal with. Administrators and Principals can improve the teaching of students by suggesting different strategies of problem solving for students having differential cognitive style and intelligence.

6.13 SUGGESTIONS FOR FURTHER STUDIES:

1. Research studies may be conducted by taking other problem solving strategies in other school subjects.

2. The present study can be replicated involving more complex problems from Chemistry, Physics and Mathematics at high-school stage.

3. In studying the efficacy of problem solving strategies in relation to anxiety level, cognitive style and intelligence, the following factors can be added:

   i) Sex
   ii) Personality
   iii) Age of the student
   iv) Socio-economic status
   v) Socio-emotional climate of the class.
4. For arriving at results having wider applicability the present study may be conducted on the large samples.

5. Different situations for problem solving may be taken up to study the contributory factors in other fields also.