INTRODUCTION

There have been dramatic changes in the concept of education and the way it was organised as a chain of input, process and product in a system. The purpose of Education is to affect students learning and the value of any technology must therefore be measured by its capacity to affect learning. In a wider perspective, technology today seems to hold out more benefits than ever before. The influence of electronic media has brought a revolution in the field of Education. Ratio, Television, Video Cassettes, Tape Recorder, Computer Assisted learning etc. along with various models of teaching are being increasingly used in field of Education.

Models of teaching are designed to import repertories while helping students learn information, ideas, academic skills, developing social skills, values and understand themselves and their environments (Joyce and Weil, 1960).

Joyce (1960) defined the model of teaching as on instructional design. It helps the processing and guide the way as a result of which they can improve their ability to master information.

Bruner concept attainment model states that role of teacher is to create situation in which students can learn on their own rather than to provide packaged information to students.
The process of learning begins with the birth of the child and continues till his death. As soon as he comes in contact with his environment, he starts reacting and in the process of interaction of the individual and his environment, the foundation of learning is laid down.

Each individual has preferred ways of organising all that he sees, remembers and thinks about consistent individual differences in these ways of organising and processing information and experiences have come to be called as "Cognitive styles". These styles represent consistencies in the manner or form of cognition as distinct from the content of cognition or the level of skill displayed in the cognition performance. Cognitive styles are conceptualised as stable attitudes, preferences or habitual strategies determining a person's typical modes of perceiving, recovery, remembering, thinking and problem solving (Hilgard and Bower, 1986).

5.1. REVIEW OF RELATED STUDIES

The series of related studies is very important aspect in the planning of a new study. The review of related studies helps us to know what others have tried to find out and what problems remain to be solved. It helps researchers to eliminate the duplication of what has been already done and it provides useful hypotheses and helpful suggestions for further investigations. Here the review of the related studies is given according to teaching strategies, cognitive styles and Piaget's developmental stages in relation to achievement.

5.1.1 Teaching Strategies and Achievement

Kochhar S. Rajiv (1993) studied the effectiveness of Hilda Taba's Inductive thinking model and Bruner's concept attainment model of teaching
in learning of concepts in science and found that both strategies were equally good in learning of concepts in science.

Singh (1993) studied effect of mastery learning strategies on acquisition of algebraic concepts and found that mastery learning strategy is superior in teaching algebraic concepts to IX class students.

Chopra Seema (1994) studied that both models i.e. concept attainment model and conventional models are equally good in learning of concepts in English language.

Singh (1994) found that Inductive thinking model was more effective than traditional method in terms of achievement in Economics.

Gupta (1995) concluded that out of three information processing models of teaching employed for teaching science concepts, concept attainment model and inductive thinking model were found to be superior to advance organiser model of teaching for teaching the concepts of science to class-IX students.

Naik (1997) found Inductive thinking model effective in increasing reasoning ability and achievement and retention in mathematics as compared to the traditional method of teaching.

Mehra and Sangwan (1998) concluded that AOM of teaching was more effective than traditional classroom teaching in the regiment of Biology at school level.
Bhushan and Mehar (1999) found AOM as effective as traditional method of teaching in high school geography.

Vandana Mehra and Khare Sharad Bala (2002) studied the effect of ITM, AOM and conventional method of teaching on achievement of B.Ed. students in educational technology and found that ITM was effective as compared to conventional method and AO does not facilitate learning.

5.1.2 Cognitive Styles and achievement

Gautam Gargi (1992) conducted an investigation on the effect of inquiry training model on achievement of adolescents studying economics in relation to their cognitive style and found that interaction between teaching models and different levels of cognitive style was found to be insignificant.

Sandhu (1992) found that the group having field independent cognitive style scored higher mean than field dependent group in achievement test.

Ganihar (1993) in her study on a sample of 200 students of class-IX of four schools of Dharwad city found that there was significant relationship between cognitive style and academic achievement in social studies, language, mathematics, science and English.

Krank (1993) found no statistically significant predictive power for cognitive style or treatment condition. 'Pre-service teachers' cognitive styles did not significantly contribute to enhanced critical thinking, abilities.

Custer Thomas Alan (1994) indicated that students with strong independent learning styles showed significantly higher chemistry achievement and greater achievement gains.
Devinder Kumar (1995) studied effectiveness of mastery learning strategies on achievement in economics in relation to cognitive style and found that field dependent and field independent students did not differ significantly on the achievement of economics concepts.

Mehar Ram (1997) studied the role of advance organizer model in learning and retention with respect of cognitive style and learning types in geography and found that there is no difference in the gain mean scores yielded by the subjects having field dependent style and field independent cognitive styles.

5.1.3 Piaget's Developmental Stages and Achievement

Gurinderjit K. Bal (1992) studied effect of audio-visual instructions on acquisition of concepts at Piaget's concrete and formal operation stages and found that out of three modes of instructions used for teaching concepts in the subject of social studies, Audio visual instructions with verbalization proved to be the most effective method than other two modes of instructions at the concrete operation stages.

Kyhl (1994) in a study on 104 subjects (8 to 18 years that is grade III to XII) reported that the order of the attainment of the classification structures is class inclusion, vicariance, classes in hierarchy and rectangular arrays. Significant relationship between task performance and grade level and no significant relationship between task performance and gender were also reported in the study.

Kimmins (1994) conducted a study on children ages 4 to 7 years to find out the relationship between young children's understanding of randomness and piagetian developmental level. It was observed that some
children as young as it could distinguish between a determine and a fortuitous outcome when the criteria for understanding was judgement as opposed to judgement plus explanation. No children age 4 and few children ages 5, 6, 7 years provide adequate explanations.

Kaur Jagdip (1996) conducted her investigation on the development of piagetian concrete operational thinking and ability to verbalize reasoning as related to creative performance and found that hypothesis the development of conservation, serration and classification abilities of piagetian concerte operational thinking takes place from grade-III through VI representing age group of 8+ through 11+ years stands accepted. Malathi Rajgopalan (1996) developed path model for formal operational thinking and found that the potential ability measured in terms of I or has the highest influence on the development of formal reasoning.

Very few studies have been conducted in which two or more strategies at piagets two developmental stages namely concrete operations and formal operations have been compared to teach a particular skill. So the present study entitled as "Effectiveness of teaching strategies in the acquisition of science concepts in relation to intelligence, cognitive styles and gender differences" was undertaken with a view to investigate the efficacy of the teaching strategies in relation to cognitive styles, intelligence and gender difference for V and IX class students.

5.2. STATEMENT OF THE PROBLEM

The problem was stated as follows:

"Effectiveness of teaching strategies in the acquisition of science concepts in relation to intelligence, cognitive styles and gender differences."

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5.3. OBJECTIVES OF THE STUDY

The following were the objectives of the study:

- To compare the different teaching strategies of concept attainment model over the traditional method in teaching of science concepts.
- To see the effectiveness of the strategies of concept attainment model in teaching science concepts to concrete operations stage (7-11 years age group).
- To see the effectiveness of the strategies of concept attainment in teaching science concepts to formal operations stage (12 years onwards).
- To see the effect of cognitive style on acquisition of science concepts irrespective of strategy of teaching.
- To see the effect of intelligence on acquisition of science concepts irrespective of strategy of teaching.
- To see the effect of gender on acquisition of science concepts irrespective of strategy of teaching.
- To see the international effect of cognitive styles and intelligence on acquisition of science concepts.
- To see the interactional effect of cognitive styles and gender difference on acquisition of science concepts.
- To see the interactional effects of cognitive styles and teaching strategies on acquisition of science concepts.
- To see the interactional effects of Teaching Strategies and intelligence on acquisition of science concepts.
5.4. HYPOTHESES

Main effects
- There will be significant mean differences in achievement of pupils taught through different teaching strategies at concrete operations stage.
- There will be significant mean differences in achievement of pupils taught through different strategies at formal operations stage.
- There will be significant mean differences between male and female pupils in terms of acquisition of science concepts.

The following will be the interactional hypotheses for both the stages of development, namely, concrete operations and formal operations:

First Order interactions:
- There will be significant interaction between type of strategies and level of intelligence.
- There will be significant interaction between type of strategies and male and female pupils.
- There will be significant interaction between type of strategies and cognitive styles.
- There will be significant interaction between levels of intelligence and male and female pupils.
- There will be significant interaction between level of intelligence and cognitive styles.
- There will be significant interaction between cognitive styles and male and female pupils.

Second Order interactions:
- There will be significant interaction among levels of intelligence, gender and cognitive styles.
There will be significant interaction among teaching strategies, intelligence and gender differences.

There will be significant interaction among teaching strategies, gender differences and cognitive styles.

There will be significant interaction among gender differences, intelligence and cognitive styles.

**Third Order interaction**

There will be significant interaction among teaching strategies gender intelligence and cognitive styles.

5.5. **SAMPLE**

Present study was concerned with different teaching strategies at two levels of developmental stages. Hence two types of sample were taken.

Sample A: 240 students from Class-V for concrete operations stage.
Sample B: 240 students from Class-IX for formal operations stage.

Different schools were randomly taken from Ludhiana district and pupils were taken in clusters from Class-V and IX because the design of the study required an intact group for instructional strategies. The sample groups for analysis were formed according to the requirements of 3x2x2x2 factorial design. The top and bottom groups on the basis of the variable of intelligence were made according to Kelley's (1939) consideration of top 27% students forming the high group and bottom 27% students forming the low group. The sampling groups for sex were formed as boys and girls. The sampling groups for cognitive styles were formulated as field independent (27% top) and field dependent (27% bottom). Each of the eight groups based on the 2x2x2 factorial design (two levels each of intelligence and cognitive styles and sex) was subdivided into three groups based upon the three teaching strategies. Therefore 24 groups were formulated as per requirements of
the 3x2x2x2 factorial design. Sample size was kept equal in all the 24 conditions on random basis. The sample size for the final experiment was 120 students (for formal operations stage) and 144 students (for concrete operations stage).

5.6. TOOLS OF STUDY

The following tools and tests were used for collecting data:

- **Two achievement tests** (one each for concrete operations stage and formal operations stage) developed and standardised by the investigator were used to test the achievement of students as a pre-test and post-test.

- **Group Embedded Figure Test (GEFT)** developed by Witkin, Oltman and Ruskin in (1971) and published by consulting Psychological Press Inc. was selected to identify the cognitive styles of students. The GEFT contains three sections. The first section contains seven very simple items and is primarily for practice each of the second and third sections contains more difficult items. The test was administered strictly in accordance with the instructions given in the manual. The raw scores were used to classify the students into two groups i.e. field-independent and field-dependent.

- **Standard progressive matrices** developed by Raven (1958) and published by H.K. Lewis and Co. Ltd. were taken to measure the intelligence of students. The scale consists of 60 problems divided into five sets of 12 each. In each set the first problem is nearly self evident. The problems which follow become progressively more difficult as the order of the problem provides the standard training in the method of working. A person's total score provides an index of his intellectual capacity. The test was administered strictly in accordance with the instructions given in the manual. The raw scores were used to classify the students into two levels (high and low) on the variable of intelligence.
5.7. DESIGN OF STUDY

The study was based upon 3x2x2x2 factorial design. The variables of cognitive styles and intelligence are independent variables whereas the variable of achievement in concept learning is the dependent variable. The variable of cognitive styles (D) was varied at two levels - Field-independent (D₁) and Field-dependent (D₂). The variable of intelligence was varied at high and low levels designated as C₁ and C₂ respectively. The classification variable of Sex (B) was studied at two levels - Boys (B₁) and Girls (B₂). The variable of teaching strategies was also varied at three levels. Reception strategy (A₁) selection strategy (A₂) and traditional method (A₃).

The layout of the design is as given in figure:-

A₁, A₂, A₃ - Teaching strategies
B₁ - Boys
B₂ - Girls
C₁ = High Intelligent group
C₂ = Low Intelligent group
D₁ = Field Dependent
D₂ = Field Independent.
5.8 STATISTICAL ANALYSIS OF DATA

1. Appropriate descriptive statistics like Mean, Median, Mode, Skewness and Kurtosis were computed and accordingly frequency polygons were also drawn to show the normal distribution of different scores.

2. For standardizing Achievement tests item-analysis, reliability and validity were calculated by using appropriate statistical techniques.

3. The four-way analysis of variance was computed to find out the main and interaction effects of independent variables on achievement. T-ratios were also computed in all the cases on which F-ratios were significant.

5.9 RESULTS

The data were analysed using descriptive statistics such as Mean, Median, Standard Deviation, Skewness and Kurtosis. The four way analysis of variance was done to find out the main and interaction effects of independent variables on achievement. T-ratios were also computed in all cases in which F-ratios were significant.

Table 5.1
Summary table showing Mean, Median, S.D., Sk & Kur of groups
A₁, A₂, A₃ & Total sample at formal operation stage IX class.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Median</th>
<th>S.D.</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>A₁ (80)</td>
<td>43.08</td>
<td>43.94</td>
<td>3.88</td>
<td>-1.99</td>
<td>0.0392</td>
</tr>
<tr>
<td>A₂ (80)</td>
<td>40.825</td>
<td>42.50</td>
<td>3.91</td>
<td>-1.28</td>
<td>0.075</td>
</tr>
<tr>
<td>A₃ (80)</td>
<td>39.025</td>
<td>39.63</td>
<td>3.84</td>
<td>-0.472</td>
<td>0.0532</td>
</tr>
<tr>
<td>Total Sample (240)</td>
<td>42.025</td>
<td>42.28</td>
<td>4.21</td>
<td>-0.538</td>
<td>0.193</td>
</tr>
</tbody>
</table>

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Table 5.2
Summary table showing mean, median, S.D., Sk, Kur. of group A, A & A and total samples at concrete operations stage V Class.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Median</th>
<th>S.D.</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_1$ (80)</td>
<td>30.76</td>
<td>30.39</td>
<td>4.40</td>
<td>0.252</td>
<td>0.050</td>
</tr>
<tr>
<td>$A_2$ (80)</td>
<td>27.76</td>
<td>26.30</td>
<td>4.40</td>
<td>0.331</td>
<td>0.378</td>
</tr>
<tr>
<td>$A_3$ (80)</td>
<td>27.92</td>
<td>28.38</td>
<td>4.41</td>
<td>-0.318</td>
<td>0.03</td>
</tr>
<tr>
<td>Total Group (240)</td>
<td>28.81</td>
<td>28.91</td>
<td>4.76</td>
<td>-0.063</td>
<td>0.079</td>
</tr>
</tbody>
</table>

t-ratios were also computed following are tables of significant t-ratios. For $A \times C$ and $A \times B \times C$ at formal operations stage IXth class.

Table 5.3

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Variable</th>
<th>No.</th>
<th>Mean</th>
<th>S.D.</th>
<th>T-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>$A_2C_1$</td>
<td>24</td>
<td>7.88</td>
<td>3.31</td>
<td>0.71</td>
</tr>
<tr>
<td></td>
<td>$A_2C_1$</td>
<td></td>
<td>7.25</td>
<td>2.79</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>$A_2C_1$</td>
<td>24</td>
<td>7.88</td>
<td>3.31</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>$A_2C_1$</td>
<td></td>
<td>8.3</td>
<td>4.20</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>$A_2C_1$</td>
<td>24</td>
<td>7.25</td>
<td>2.79</td>
<td>1.02</td>
</tr>
<tr>
<td></td>
<td>$A_2C_1$</td>
<td></td>
<td>8.3</td>
<td>4.20</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>$A_2C_2$</td>
<td>24</td>
<td>8.5</td>
<td>4.32</td>
<td>3.75*</td>
</tr>
<tr>
<td></td>
<td>$A_2C_2$</td>
<td></td>
<td>4.75</td>
<td>5.74</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>$A_2C_2$</td>
<td>24</td>
<td>8.5</td>
<td>4.32</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>$A_2C_2$</td>
<td></td>
<td>8.5</td>
<td>2.16</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>$A_2C_2$</td>
<td>24</td>
<td>4.75</td>
<td>5.45</td>
<td>5.85*</td>
</tr>
<tr>
<td></td>
<td>$A_2C_2$</td>
<td></td>
<td>8.5</td>
<td>2.16</td>
<td></td>
</tr>
</tbody>
</table>

* Significant at $t = 2.81$ at .01 level (df = 23)

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Table 5.4
t-ratios for the Interpretations of the (A x B x C) at
Formal Operations Stage (IX Class)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Variable</th>
<th>No.</th>
<th>Mean</th>
<th>S.D.</th>
<th>t-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>A&lt;sub&gt;2&lt;/sub&gt;B&lt;sub&gt;1&lt;/sub&gt;C&lt;sub&gt;1&lt;/sub&gt;</td>
<td>12</td>
<td>12.25</td>
<td>3.60</td>
<td>3.01*</td>
</tr>
<tr>
<td></td>
<td>A&lt;sub&gt;2&lt;/sub&gt;B&lt;sub&gt;2&lt;/sub&gt;C&lt;sub&gt;1&lt;/sub&gt;</td>
<td></td>
<td>8.09</td>
<td>3.19</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>A&lt;sub&gt;1&lt;/sub&gt;B&lt;sub&gt;1&lt;/sub&gt;C&lt;sub&gt;1&lt;/sub&gt;</td>
<td>12</td>
<td>12.25</td>
<td>3.60</td>
<td>2.68*</td>
</tr>
<tr>
<td></td>
<td>A&lt;sub&gt;2&lt;/sub&gt;B&lt;sub&gt;1&lt;/sub&gt;C&lt;sub&gt;1&lt;/sub&gt;</td>
<td></td>
<td>7.66</td>
<td>4.71</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>A&lt;sub&gt;1&lt;/sub&gt;B&lt;sub&gt;1&lt;/sub&gt;C&lt;sub&gt;1&lt;/sub&gt;</td>
<td>12</td>
<td>12.25</td>
<td>3.60</td>
<td>0.26</td>
</tr>
<tr>
<td></td>
<td>A&lt;sub&gt;2&lt;/sub&gt;B&lt;sub&gt;1&lt;/sub&gt;C&lt;sub&gt;1&lt;/sub&gt;</td>
<td></td>
<td>7.66</td>
<td>4.71</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>A&lt;sub&gt;1&lt;/sub&gt;B&lt;sub&gt;2&lt;/sub&gt;C&lt;sub&gt;2&lt;/sub&gt;</td>
<td>12</td>
<td>12.25</td>
<td>3.60</td>
<td>0.26</td>
</tr>
<tr>
<td></td>
<td>A&lt;sub&gt;2&lt;/sub&gt;B&lt;sub&gt;2&lt;/sub&gt;C&lt;sub&gt;2&lt;/sub&gt;</td>
<td></td>
<td>7.66</td>
<td>4.71</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>A&lt;sub&gt;1&lt;/sub&gt;B&lt;sub&gt;2&lt;/sub&gt;C&lt;sub&gt;2&lt;/sub&gt;</td>
<td>12</td>
<td>12.25</td>
<td>3.60</td>
<td>0.26</td>
</tr>
<tr>
<td></td>
<td>A&lt;sub&gt;2&lt;/sub&gt;B&lt;sub&gt;2&lt;/sub&gt;C&lt;sub&gt;2&lt;/sub&gt;</td>
<td></td>
<td>7.66</td>
<td>4.71</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>A&lt;sub&gt;1&lt;/sub&gt;B&lt;sub&gt;2&lt;/sub&gt;C&lt;sub&gt;2&lt;/sub&gt;</td>
<td>12</td>
<td>12.25</td>
<td>3.60</td>
<td>0.26</td>
</tr>
<tr>
<td></td>
<td>A&lt;sub&gt;2&lt;/sub&gt;B&lt;sub&gt;2&lt;/sub&gt;C&lt;sub&gt;2&lt;/sub&gt;</td>
<td></td>
<td>7.66</td>
<td>4.71</td>
<td></td>
</tr>
</tbody>
</table>
5.10 CONCLUSIONS

On the basis of analysis and obtained results the following conclusions have been arrived at:

- Major finding of the present study is that out of three teaching strategies used for acquisition of science concepts the Reception strategy was found to be superior than Selection strategy and Traditional strategy at both the developmental stages (formal operations and concrete operations).

- Traditional teaching method proved to be better method to acquire science concepts by low intelligent group and low intelligent students showed poor acquisition of concepts taught by selection strategy at formal operations stage.

- Intelligence acted as redundant factor so far as acquisition of science concepts was concerned at concrete operations stage.

- It was found that boys and girls did not differ significantly in achievement in acquisition of science concepts irrespective of strategies of teaching at formal operations as well as concrete operations stage.

- Students with field dependent and field independent cognitive styles did not show any significant difference in achievement in acquisition of science concepts at both stages.

- Variables of cognitive styles and gender were independent of each other in acquisition of science concepts.

- Variables of Intelligence and cognitive styles were independent of each other in acquisition of science concepts.
Variables of Teaching strategies, gender and cognitive styles did not interact significantly in acquisition of science concepts at formal operation stage.

Variables of Teaching strategies, Intelligence and gender differences were independent of each other in acquisition of science concepts at both stages.

Variables of gender differences, intelligence and cognitive styles did not differ significantly in acquisition of science concepts.

5.11 IMPLICATIONS AND APPLICATIONS OF THE STUDY

The findings of the present study have some important implications in the acquisition of science concepts at Piaget's two developmental stages that can be summarised as follows:

Reception strategy of Concept Attainment Model was found to be superior to selection strategy and traditional strategies. So the Science teacher must use reception strategy of Concept Attainment Model to teach science concepts. Reception strategy is useful for both the developmental stages i.e. concrete and formal operations stage.

The teachers can make use of the findings of the study with regard to the non-significance of differences in the cognitive styles. Levels of intelligence, also, have not shown marked differences in both the extreme groups on the basis of achievement. The grouping of the students on the variable of intelligence may not be insisted upon in the school situations.

The school administrators, the guidance workers and the students can take cues from the results of the present study regarding the effect
of the variables of intelligence, cognitive styles and sex on academic achievement findings may be used for ensuring better achievement in case of the learners.

5.12 SUGGESTIONS FOR FURTHER RESEARCH

1. Since the present study was confined to Ludhiana Distt. the similar research can be conducted at State level also.

2. A similar investigation can be conducted for different Educational levels i.e. college and university levels and in different subjects.

3. A research may be conducted by involving more variables viz., Personality, Creativity Socio-Economic status, teaching strategies etc. and their effect studied on learning of rules, principles etc.

4. The present study may be replicated on a larger population for greater validation of results.

5. Research may be conducted by comparing different models of teaching e.g. Inductive thinking model, computer assisted and other teaching strategies.