Chapter 3

METHOD AND PROCEDURE
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The main focus of the present investigation was to find out the impact of different teaching strategies on the development of divergent production abilities of 10th grade female students.

The comparisons were made between traditional method of teaching science and teaching strategies such as problem solving and inquiry training to find out the impact of each strategy on the development of divergent thinking of female students. Hence, the research method adopted was an experimental one.

Sample

It was not possible to include all the 10th grade female students of background hilly regions of Kashmir; therefore, Baramulla hilly region was taken. First, a list of all high and higher secondary schools falling in the Baramulla hilly region was prepared. Then the number
of female students studying in these institutions was also prepared. Both the schools and students were selected through random sampling method. In all initially, 400 female 10th grade students were taken up.

Divergent production abilities test developed by K. N. Sharma was administered to them to find out their scores on divergent thinking. To minimize the variance among different groups, the subjects (students) were equated on general mental ability, scholastic achievement and parental education by administered tests of intelligence and socio-economic status scales. The formation of groups is given in the following table:

**Table 3.0  Description of the Sample**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Variables</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Group</td>
<td>Students taught through Traditional Method of Teaching</td>
<td>70</td>
</tr>
<tr>
<td>Experimental</td>
<td>Students taught through Inquiry</td>
<td>70</td>
</tr>
<tr>
<td>Group-1</td>
<td>Training</td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>Students taught through Problem</td>
<td>70</td>
</tr>
<tr>
<td>Group-2</td>
<td>Solving</td>
<td></td>
</tr>
</tbody>
</table>

**Total** 210
Hypotheses

The following hypotheses have been formulated for the present investigation:

1. The three groups of the 10th grade students following problem solving, inquiry and traditional methods of teaching will differ significantly in their mean fluency (word, ideational, associational and expressional), flexibility (spontaneous and adoptive) and originality scores.

2. The teaching through problem solving and inquiry training will have positive and significant effect in the enhancement of mean fluency (word, ideational, associational and expressional), flexibility (spontaneous and adoptive) and originality scores of the two groups of the 10th grade female students.

3. The three groups of the 10th grade female students following problem solving, inquiry training and traditional method of teaching will differ significantly in their mean total divergent thinking scores.

4. The teaching through problem solving, inquiry training will have positive and significant effect on the enhancement of
mean total divergent thinking scores of the two groups of 10th grade female students.

5. The three groups of 10th grade students following problem solving, inquiry training and traditional method of teaching, will differ significantly in their mean elaboration scores.

6. The teaching through problem solving and inquiry training will have positive and significant effect on the enhancement of mean elaboration scores of the three groups of the 10th grade female students.

7. The three groups of the 10th grade students following problem solving, inquiry training and traditional method of teaching will differ significantly in their mean originality scores.

8. The teaching through problem solving, inquiry training will have positive and significant effect in the enhancement of mean originality scores of two groups of the 10th grade female students.

9. The three groups of 10th grade students following problem solving, inquiry training and traditional method of teaching will differ significantly in their mean total divergent thinking scores.

10. The teaching through problem solving, inquiry training will have positive and significant effect on the enhancement of
mean divergent thinking of three groups of 10th grade female students.

11. The three groups of the 10th grade students following problem solving, inquiry training will have positive and significant effect on the enhancement of mean total divergent thinking of two groups of the 10th grade female students.

Description of Tools

The following tools were used to collect the data for the present investigation:

Divergent Production Abilities Test

The divergent production ability test developed by K. N. Sharma was used to collect the data on the divergent thinking of subjects. This scale contains six tests for measurement of the eight abilities given below:

- Word Fluency
- Ideational Fluency
- Associational Fluency
- Expressional Fluency
- Spontaneous Flexibility
Adaptive Flexibility

Originality

Elaboration

**Word Fluency** is to give words to stimulate. Words may be synonyms or antonyms as asked for. It is more a vocabulary test.

**Ideational Fluency** is generation of more ideas to stimulate, may be word, phrase, sentence, story, quality or any idea, etc.

**Expressional Fluency** is to produce many ideas to fit a system or logical theories, may be in the form of sentences or verbal ideas etc.

**Associational Fluency** is to produce ideas or words from a restricted area, i.e. of relationship. It requires completion of relations, like production of relations, generation of synonyms, analogies, similarities, problems of likeness, etc.

**Spontaneous Flexibility** is production of a diversity of ideas in a relatively unrestricted situation. It may include variety of kinds of responses into classes, like number of considerations, or properties, attributes, or inherent characteristics of problem or product, number of shifts of category responses, versatility, etc.

**Adaptive Flexibility** involves changes—changes in interpretation of task, in approach, or strategy or in possible solutions.
**Originality** measures quality. It indicates uncommonness or newness in the product. Various names, like new, uncommon, unusual, clever, singular, individual, surprise, etc. are used to designate originality.

**Elaboration** indicates expanding or combining activities of higher thought. It is to provide specification of details that contribute to the development of a general idea. It shows production of detailed steps, variety of implications and consequences which can be quantitatively measured.

**General Mental Ability Test**

Mixed type group test of intelligence developed by P. N. Mehrotra was used to collect the data on the verbal and non-verbal intelligence of the subjects.

**Socio-Economic Status (SES) Scale**

SES scale developed by Rajeev Bharadwaj was used to assess the socio-economic conditions especially parental education of the subjects.
Scholastic Achievement

The marks obtained by the sample subjects in their previous examination were taken, as an index of their scholastic achievement.

Teaching Strategies

The teaching strategies involved in the present study are operationally defined as under:

Traditional Method of Teaching Science

This method involves the steps such as, statement of the objectives, previous knowledge testing, presentation and application. Teachers in their classrooms to teach science to their students generally use this method. The education we impart today to our children merely centres on the learning, which at the best helps them in the acquisition of certain information, desirable habits patterns, and skills. What is more important is to prepare them to meet their individual needs efficiently and effectively on the one hand, contribute their mite to the good of the society, and be a source of satisfaction to themselves on the other. This necessitates the shifting of emphasis from mere routine-type of teaching and learning to creative problem solving and learning. The purpose is best achieved when besides conducive atmosphere in the homes, there is effective
environment in the schools and the class rooms wherein the teachers as well as the students are willing to play their new roles—the teachers are prepared to shed their traditionally authoritarian roles and structure the educative process in the way that the students are stimulated to explore problems for themselves and seek their solutions and the students are prepared to leave the stereotyped thinking and learning and strive for self-actualisation and initiate the learning on their own.

National Education commission (1964-66) points out that education system is hardly designed to encourage initiative, creativity and experimentation on a large scale and is, therefore, not able to keep itself abreast of times. The Commission has vehemently stressed innovative teaching strategies in place of traditional approach in teaching. The academic talent we consider simply a talent which enables a student to pass an examination and that too the traditional type examination wherein the student needs only a minor part of the academic talent. In fact, no nation can afford to overlook the importance of other talents for its growth on the one hand and preparing individuals as fully functioning persons on the other.
Problem Solving Strategy

The investigator developed this strategy herself on the lines suggested by Guilford in his problem-solving model. Problem solving is a group activity where the students work together and in a spirit of cooperation. The problem solving activity means a process, employed by the teachers in the classroom, of discovering or deducting new relationships among things observed by the teachers in the classroom, of discovering or deducting new relationships among things observed or sensed including conscious or subconscious assumption, or hypotheses, of a possible relationship within a simple or complex system of thought and understanding, and means to test through experience the acceptability of assumption. The process is equivalent to research when there is refinement of the system and of process in starting and investigating the hypotheses. The solution of a problem by a student implies discovery of a relationship, which is accepted as adequate by him; the further testing of a solution is through search for agreement with the experience of the individual and with the discoveries of similar nature by other investigators in the group of learners. Research on problem solving has had a varied history. Before the 1930’s, most textbooks still treated logic in considerable detail, making it the basis for intelligent or rational behaviour. This was quite natural, since psychology was an offshoot of the philosophy of mind. Thinking and
questions of consciousness, imageless thought, associative "set" and concept formation were the subject matter of research in thinking (Woodworth 1938).

Perhaps the greatest impetus to research in problem solving came from studies of animals seeking to investigate into the rationality. History reveals that philosophers had attributed reason and soul to man alone. Thorndike (1913) initiated an experimental approach to the analysis of problem-solving behaviour by developing the problem box and observed how cats found their way to food. This led to a whole series of problem-box mastery as the development of motor habits and grouped it with maze learning. The problem solving became classified with learning. The method used in the problem solving was referred to as trial and error.

Various types of puzzles have been used to study human problem solving; as a result, trial and error has become a generally accepted mechanism. Dewey (1913) used the concept of the account for human problem solving by describing a process he called mental trial and error. In way, the problem solving capacity of the trial- and -error process was expanded. At the same time, it gave man a kind of superiority over animals in that he could eliminate incorrect alternatives without trying them out behaviourally.

It was only after World War-II when research finds for investigations of creativity and originally were made available, a new
name for a higher type of problem solving was accepted, the implication being that creativity included more than learning and intelligence. Although it had long been recognised that intelligence and problem solving ability had a limited relationship, the recent research had revived the importance of distinguishing between intelligence (the ability to learn) and creativity. The work of Getzels and Jackson (1962) and Torrance (1965) revealed this trend, which lays emphasis on unusual, innovative types of personality. This, of course, is required when an individual is faced with a new situation that poses a problem. A problem becomes difficult when its solutions require responses that deviate from the common ones or from previously learned ones. Approached in this way, it follows that the creative person should be a good problem solver because he can solve not only routine problems but also all those that require more than a learning mechanism.

Problem-solving methods being used are often classified as "traditional" and "new". Traditional methods are more rational and logical while as the new methods attempt to train the individual through freeing him from his emotional inhibitions. Generally, problem-solving method involves the following steps:

1) **Definition of the Problem**  It involves definition of the initial problem as well as establishment of the problem.
2) **Searching for Methods**  It involves searching for different methods, evaluating them and finally selection of the suitable method takes place.

3) **Preparation of the Design**  In it, an outline of the design is prepared, test is conducted and evaluation is done.

4) **Results and Solution**  It involves generalising the results and arriving at the best solution.

The problem solving is a process of overcoming difficulties that appear to interfere with the attainment of goal. It is a procedure of making adjustments in spite of interferences.

The problem solving is the application of new solutions to old problems. It is also regarded as putting of two or more previously unrelated elements together to arrive at a novel solution.

Good (1973) defined problem-solving method as a technique of instruction by which learning is stimulated by the creation of challenging situations that demand solution, i.e. a major problem is solved through the combined solution of a number of small related problems. The problem method aims at presenting the knowledge to be learnt in the form of a problem, the solution of which requires activity on the part of the pupils and indirectly they acquire the needed knowledge.
Inquiry Training

Inquiry training model was developed by Richard Suchman (1962) to teach students a process for investigating and explaining unusual phenomenon. The main objective underlying the model was that the scientific process skills are developed in the pupils to enable them to organise data, reason about cause-and-effect, and build and test theories. He modelled the model along the lines of the methods employed by components of the inquiry process and built them into the instructional model to which he called inquiry training.

Suchman bases his inquiry training approach on the four postulates. First, the children are curious and eager to grow by nature. He emphasises that when children are faced with a puzzling situation they naturally get motivated to explore the data surrounding the discrepant event and think of arranging the data in new ways to find answers to the problem. The general goal of inquiry training is to help students develop the intellectual discipline and skills necessary to raise questions and search out answers stemming from their curiosity. Second, the process of inquiry can be taught to students. Suchman believes that students can become increasingly conscious of their process of inquiry, and that they can be taught scientific procedures directly. He emphasises that we cannot analyse and improve our thinking unless we are conscious of it. Third, team approach is more useful than the individual approach to find solution.
to a problem. Suchman believes that the viewpoint of a second person enriches our thinking, and that it is the cooperative inquiry that leads to the development of new knowledge. Fourth, all knowledge is tentative. Suchman emphasises that the students should be made aware of the fact that all knowledge is tentative. Scholars constantly generate theories and explanations. After sometime, these theories are replaced by new ones, which conveys that are no permanent answers to problems; new and sophisticated ways are investigated to reach the solution of the problem, or new ways are detected to look at the problem itself.

Inquiry Training Process

In “Inquiry Training”, the students are presented with a problem situation such as, an episode, experiment, story, etc, and are asked to inquire into it. In whatsoever form it is presented, it must essentially carry a discrepancy leading to a puzzle. Since the ultimate goal is to have students experience the creation of new knowledge, the confrontation should be based on discoverable ideas.

After the presentation of a puzzling situation, the students are encouraged to ask questions. These questions have to be worded in the way that they are answered by a yes or no. The students may not ask the teacher to explain the phenomena to them; however,
they can ask questions that are responded by the teacher only in a yes or a no. Whenever a question cannot be replied in a yes or no response, the teacher reminds of the proper form. Comments such as, "can you restate this question so that I can answer it with a yes or a no; are common teacher responses when students slip out of the inquiry mode.

Thus, at the first stage of the inquiry process, the students are taught to verify the facts of the situation, i.e. the nature and identity of the objects, the events, and the conditions surrounding the puzzling event. As the students become aware of the facts, they form hypotheses, which guide them in their future inquiry. Using their knowledge about the behaviour of objects, students can turn their questions to the variables in the situation. This they can do by conducting verbal or actual experiments to test these causal relationships, selecting new data, or organising the existing data in new ways to see what will happen if things are done differently. It may not be possible for the students to frame proper questions to test the causal relationships between variables unless they have sufficient information about the nature of the problem situation and its elements, and it is likely that they are to be overwhelmed by the many possible causal relationships.

Finally, the students try to develop hypotheses that will fully explain what happened. In other words, it means that they reach the
final explanation; however, they need to be cautioned that there can be many possible explanations that appear to fit the facts.

The main emphasis in this approach is on becoming aware of and mastering the inquiry process and not the content of any particular problem situation. The teacher also need not be too concerned with subject matter coverage or “obtaining the right answer” for the reason that it would violate the real spirit of scientific inquiry, which emphasises team approach of searching together for more accurate and powerful explanations for everyday phenomenon.

Phases in Inquiry Training

There are five phases (steps) in the inquiry training process. The first phase is the students' confrontation with the puzzling situation. The second and third phases concern with the data gathering mechanisms of verification and experimentation. In the fourth phase, students organise the data and try to explain the discrepancy. Finally, in the fifth phase, the students reflect on the problem-solving strategies they used during the inquiry.

Phase I: Encounter with the Problem  In this phase, the teacher is required to present the problem situation and explain the inquiry procedure to the students. The teacher is required to satisfy himself that the students have understood the inquiry procedure pattern of the yes-no question and the objectives fully. Then he can
present problem situation to the students, which should essentially carry a discrepancy. The problem to be posed should be simple such as, a puzzle, riddle, or magic trick that does not require much background knowledge. However, not every puzzling situation can be a discrepant event. It is, therefore, important to note that the distinguishing feature of the discrepancy events is that it involves illogical phenomenon that conflicts with the notions of reality. A problem may be puzzling simply because we do not know the answer, but simultaneously we do not need new concepts to understand it and therefore we do not need to conduct an inquiry. Thus, the problem to be taken for inquiry should essentially accompany a discrepancy but care needs to be taken that it matches with the cognitive level of the students.

Phase II: Data Gathering-Verification In this phase, students gathers information about the problem in hand through observation or experience. They are required to ask questions about objects, properties, conditions, and events in order to identifying the objects. Properties refer to verifying the behaviour of objects under certain conditions. Conditions refer to the state of objects at a particular time, and events are related to verifying the occurrence of an action. Wherever students deviate from verifying all the aspects of the problem, the teacher reminds them of the rules of the process and makes them aware of the type of information, they are likely to seek and put them to work to change the questioning pattern.
Phase III: Data-Gathering-Experimentation  In this phase, students introduces new elements into the situation to see if the events happen differently. Exploration serves two functions, that is, exploration and direct testing. Exploration refers to changing things in order to see what will happen though it is not necessarily guided by a theory or hypothesis, but it may suggest ideas for a theory. Direct testing refers trying out a theory or hypothesis. The hypothesis determines the direction of data gathering. If the data gathered support the hypothesis, it is retained as part of the explanation. If the gathered data do not support the hypothesis it is rejected and consequently alternate hypotheses are formulated and the process is repeated.

Although verification and experimentation are described as separate phases of the inquiry training approach, yet the students' questions usually alternate between these two phases of data gathering. The teacher, thus, needs not to be very rigid in following these two phases separately instead, he should encourage students to generate questions that pertain to data gathering and lead them to formulate the explanation.

Phase IV: Formulating an Explanation  In this phase, the teacher calls on the students to formulate an explanation. It is possible that different students may put forward different explanations; however, some students may have difficulty in making
the intellectual leap between the data they have gathered and a clear explanation. It is also possible that they will give inadequate explanations omitting essential details. It has been experienced that sometimes several theories or explanations are possible based on the same information. In view of this, it is useful to ask all the students to state their explanations so that the range of differences is revealed. It is believed that the group together can shape the explanation that fully responds the problem situation.

Phase V: Analysis of the Inquiry Process  In this phase, the students are asked to analyse their pattern of inquiry. This would help them in finding out the questions that were most effective; the lines of questioning that were most productive and those that were not; or the type of information they needed but could not obtain. The teacher asks students to recall the question they have raised and to identify those questions that led them to explanation but not others. In this way, the teacher goes on repeating the whole process of inquiry so as to make students aware about the pattern of questions needed to be raised during the phases of verification and experimentation that have helped them to reach at final explanation and also making the inquiry process a conscious one so that steps are systematically taken to improve it.

Inquiry training approach promotes active, autonomous learning as the students themselves formulate questions and test
ideas. It calls upon students to take courage to ask questions, and help them to become more proficient in verbal expression as well as in listening to others and remembering what has been said.

III. Divergent Thinking Ability

Guilford defined divergent thinking as "a kind of mental operation in which we think in different directions. Sometimes seeking variety from known and remembered information", it is a type of thinking in which considerable searching about is done and the number of answers will do. Unlike convergent production where the information leads to novel responses to stimulate object. Guilford relates divergent thinking to certain well-known traits, which seem to go with creative thinking.

For the present investigation, divergent thinking means both verbal and non-verbal involving the abilities of fluency, flexibility, elaboration and originality as measured by the divergent production abilities test developed by K. N. Sharma.

The divergent thinking ability enables them the students to go off in many different directions, generating new information from the given information and arriving at varied and unusual solutions to problems. Such children do not get satisfied with the routine-type solutions to the problem like intelligent ones. They instead attempt to discover, invent, and come out with original ideas of their own. No
doubt, both the thinking abilities have their place in life but it is the divergent thinking abilities which are possibly the most useful one as these help dealing with new and complex situations of life.

Most of the subjects that are taught in the schools should, in particular be taught in ways that stimulate and develop the creative problem solving skills of students. What do we need to provide in the schools is not the content that may lead to quite predictable and uniform outcomes by the students rather the outcome should be of unpredictable and diverse nature. If we wish to create education for the young then we shall, at first, recognise that one of our main priorities should be to identify an array of problems in each of the fields we teach, as far as possible, that may provide children opportunities to create multiple solutions to identical problems. Next, we must help them to understand that most of the important problems they are likely to confront in their lives have several correct solutions, not simply one. Second, we must make it sure not only that the classroom tasks provide the children opportunities to formulate unique solutions to problems, but also, equally important, that students have opportunities to learn how to formulate questions and problems themselves. Third, creative education should aim at cultivating the students' sensibilities, the ability to sensitively experience the world so that content upon which the students can reflect would be expanded.
Design of the Experiment

The experiment was designed in the following manner:

Variables Involved

It involves the two types of variables viz. dependent variables and independent variables.

Dependent Variable The effectiveness of teaching was determined by the changes in creative thinking scores as obtained by the students on the tests of creative thinking. Thus, the creative thinking was dependent variable for present study.

Independent Variables In the present study, the curricular strategies such as traditional teaching method, inquiry training, creative problem solving were all independent variables.

Treatment

The experimental treatment to different groups were made randomly.

The treatment in terms of teaching science using various strategies was given to the selected groups of the 10th grade female students in the school that had been selected for the investigation for a period of nine weeks. A brief description of which I given as under:
Phase-I

The three identified groups of students were taught the selected course contents using traditional method of teaching by the project fellows for about three weeks. After it, they taught selected course contents of science using creative problem solving and inquiry training for six weeks.

Phase-II

At the end of the treatment, the divergent thinking was administered again to the students of all the three groups determining whether there had been any significant changes in the different dimensions of divergent thinking, i.e. fluency, flexibility, originality and elaboration of experimental groups and one control group. After scoring the test booklets, the obtained scores were tabulated to get the post-test measures of dependent variable of different components of verbal and non-verbal divergent thinking.

Procedure of Data Collection

For the present study, the researcher needed the information regarding total number of higher secondary and high schools falling in district Baramulla and especially a list of higher secondary and high schools of hilly areas of district Baramulla has been prepared. To collect this information the researcher approached the chief
education office Baramulla and the office provided the full cooperation and accurate information regarding the schools falling in hilly areas of district Baramulla. As in this study, sex has already been controlled because the sample comprises only on female students of 10th grade so the total number of female students in the institutions was ascertained. Both the schools and students were selected through random sampling method. In all initially, 400 10th grade female students were taken up and the booklets of "general mental ability test" developed by P. N. Mehrotra was used to collect the data on verbal and non-verbal intelligence of the students. To collect the information regarding this test, the investigator distributed the test booklets to the 10th grade female students of high school Chaetusa, high school Chanami, high school Balkote of hilly areas of district Baramulla. Through this way, the general Mental Ability of Students was measured and the needed data was collected.

Another test was administered on the students to collect the information regarding socio-economic status especially the parental education of the students. To collect this data the booklets of the test "Socio-economic Status" developed by Rajvee Bharadwaj was given to the subjects to assess the socio-economic condition of the subjects. The dimensions of the test are as under:

1. To collect the information regarding the educational background of the parents.
2. To collect the information regarding the socio-economic conditions as family income of the subjects.

3. To collect the information regarding the social status of both the parents.

4. To collect the information regarding the professional perspective of the parents.

After this test, the students were given another test known as "Divergent Production Abilities Test" developed by K. N. Sharma to collect the data on the divergent thinking ability of the subjects.

**Scholastic Achievements**

After collecting data on the three tests given to the subjects then the marks obtained by the sample subjects in their previous examination were taken as an index of scholastic achievement.

The researcher collected the previous examination marks in order to know the previous performance of the sample subjects and through this way all the data were collected in a proper and smooth way.

**Statistical Treatment**

The data collected were treated statistically, the description of which is given in the chapter "Analysis and Interpretation of Data".