CHAPTER 3
RESEARCH DESIGN AND METHODOLOGY

The research design is the detailed plan of the investigation. In fact, it is the “blue print” of the detailed procedure of testing the hypothesis and analyzing the obtained data. The research design may be defined as the sequence of those steps taken ahead of time to ensure that the relevant data will be collected in a way that permits objective analysis of the different hypotheses formulated with respect to the research problems. Thus, the research design helps the researcher in testing the hypothesis by reaching valid and objective conclusion regarding the relationship between independent and dependent variables.

In this chapter a description of the sample, its size research tools, administration and collection of data and statistical techniques used by the researcher for analyzing data, has been prepared.

SAMPLING, POPULATION AND SAMPLE OF THE PRESENT STUDY

Sampling is the process by which a relatively small number of individuals or measures of individuals, objects or events is selected and studied in order to draw some inferences about the entire population from which it was drawn. It helps to reduce expenditure, save time and energy permit measurement of greater scope, or produce precision and accuracy. Sampling procedures provide generalizations on the basis of a relatively small portion of population.

A population refers to a group of individuals with at least one common characteristic which distinguishes that group from other individuals. A study of the entire population is impossible due to its size, lack of time and resources. Moreover; in most of cases it is not required. To avoid these problems a smaller portion of the population is selected as a sample which is studied in detail and conclusions are drawn for the whole population.

In the present study, the target population was consisted of students enrolled in class fifth from school of city of Qom in Iran. Qom is situated on the bank of river’s Qom and is 156 kilometers southwest of Tehran. Qom consists of four educational districts. Districts 1 & 2 are non-prosperity districts having 115 schools in city. Districts 3 & 4 are prosperity districts having 169 city schools. Thus there are two clusters in our statistical population, cluster 1 and
Table 3.1 information regarding the school and the distribution in the experimental and control groups

<table>
<thead>
<tr>
<th>Name of Schools</th>
<th>Classes (6)</th>
<th>Number of Children enroled in the classroom</th>
<th>Number of Children taken for research</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3 schools)</td>
<td>Boy</td>
<td>Girl</td>
<td>Experimental</td>
</tr>
<tr>
<td>Shahid mofatteh (A)</td>
<td>■</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Kosar</td>
<td>■</td>
<td>29</td>
<td>22</td>
</tr>
<tr>
<td>Shahid mofatteh (B)</td>
<td>■</td>
<td>22</td>
<td>29</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>84</td>
<td>84</td>
</tr>
</tbody>
</table>

168 168

Table 3.1 number of children and clusters information regarding the school

cluster 2. Cluster 1 is non prosperity districts and cluster 2 is the prosperity districts. Due to paucity of time, the researcher could collect data only from few schools. Originally four schools were randomly selected for this study. Two schools namely Shahid Mofatteh A (for boys) and a different shahid mofatteh B (for girls) were selected under cluster 1, two schools namely Mirza Shirazi (for boys) and Kosar (for girls) were selected under cluster 2, but unfortunately, Mirza Shirazi school for boys did not cooperate with the researcher, therefore in effect, the children of only three schools could be studied. In each school there were two separate fifth classes. All the students enroled in a class, served as subjects of the present study. As the table 3.1 shows there were 66 boys in cluster 1 school, 33 boys in each class, and 51 girls, 22 in one class and 29 in another. In cluster two, Kosar school again there were 51 girls, 22 girls in one class and 29 in another.
The experimental group consisted of students engaged in project-based learning. The control group learned through regular methods. The experimental group consists of students who received training on project-based learning. During the 6 sessions of the classes; students were engaged in project-based learning. Before the Project Based Learning was introduced, the students were given pre-test, and after the completion of PBL post-test was given.

**INSTRUMENT/TOOLS USED:**

For collecting relevant information for the present study, four researcher-made questionnaires were used to measure the variables.

**PROJECT-BASED LEARNING QUESTIONNAIRE:**

The PBL questionnaire has been developed by Barbara A. Solomon and Richard M. Felder (in North Carolina State University on the secondary school. The inventory contains 20 items. It provides 4 separate indicator and dimensions of PBL. It also gives a total PBL score. The test was modified by the researcher to suit visually challenged students.

**CONCEPTUAL AND OPERATIONAL DEFINITION**

In order to move from general principals of theoretical framework to specific realms of the facts in this research, it becomes necessary to define the variables operationally and check their validity and reliability in a systematic way. Herein, after conceptual definition of the variables, the operational definition will be presented. A conceptual definition tells meaning of the concept, while operational definitions tell us how to measure it.

Experimental research as applied to education is defined as the application of systematic methods and techniques that help researcher and practitioners understand and enhance the teaching and learning process. (Lodico et al, 2010).

**Project-Based Learning:**

**Conceptual definition:** PBL is an approach where the teacher becomes a guide or a facilitator, while student learning has a central role. A complex task in a real-world context is presented to the students at the beginning of the project, without preliminary teaching having taken place. Through collaborative group work, students must question, discover, learn and organize the different parts of the project at hand. The ultimate goal in PBL is to
create and build a final product while gaining deeper knowledge about the content area (Moncton, 2009).

**Operational definition:** In this research PBL means style of teaching and learning that the researcher used in order to measure the influence of four variables (thinking skills, creativity, problem solving and team-collaboration) in the development of higher order thinking.

**Thinking Skills:**

**Conceptual definition:** “Thinking skills are sequences of choices, across various mental processes. The repertoire of thinking skills comprises your strengths and weaknesses in each skills area.” (Nelson, 2004, p 11)

**Operational definition:** Thinking skills in this study means, active engagement and sustained cognitive effort directed at solving a complex problem and use of prior knowledge in addressing the problem.

**Scoring:** To measure this indicator, 5 questions open-answered based upon curriculum (science book) were prepared and questioned from students that, in order to give marks, the answers are scored on the basis of 5 point Likert type scale.

**Reliability:** Reliability analysis result shows that the Cronbach’s Alpha scale value is (0.91) for 5 questions, that is, there is reasonable internal consistency and cohesion in order to measure the thinking skills’ variable.

**Face validity:** In order to move from general principals of theoretical framework to specific realms of the facts in this research, it becomes necessary to determine and check their validity in a systematic way. In order to check the face validity of the instrument in terms of item coverage, item relevance and clarity of the items, an expert panel consists one expert in Research Methodologist, one belonging to Sociology department and two to Education department who were specialized in the field of Educational Psychology judged the validity of items, whether items are appropriate to the constructs, “Thinking Skills”, In order to determine and measure the validity of questionnaire were taken the views of teachers and experts in Educational Planners and Curriculum Programmer. The appropriateness of the item was sorted out on a 5 point scale ranging from very much to very low. (Very much, much, moderate, low, very low) .The items of the test were judged by the experts mostly ranged from very appropriate to appropriate.
Creativity:

**Conceptual definition:** “Creativity involves abilities, knowledge, skills, motives, attitudes and values as well as personal properties such as openness, flexibility or courage.” (Cropley, p, 6, 2001).

**Operational definition:** In this research, creativity means pupils keep their minds open and modify their ideas to achieve creative result and look at things from different viewpoints.

**Scoring:** To measure this indicator, 5 questions open-answered based upon curriculum (science book) are prepared and questioned from students, the responses of the students were scared on five point Likert type scale.

**Reliability:** Reliability analysis result shows that the Cronbach’s Alpha scale value is (0.88) for 5 questions, that is, there is reasonable internal consistency and cohesion in order to measure the variable of creativity.

**Face validity:** In order to check the face validity of the instrument in terms of item coverage, item relevance and clarity of the items, an expert panel consists one expert in Research Methodologist, one belonging to Sociology department and one to Education department who were specialized in the field of Educational Psychology judged the validity of items, whether items are appropriate to the constructs “Creativity”, In order to determine and measure the validity of questionnaire were taken the views of teachers and experts in Educational Planners and Curriculum Programmer. The appropriateness of the item was sorted out on a 5 point scale ranging from very much to very low. (Very much, much, moderate, low, very low). The items of the test were judged by the experts mostly ranged from very appropriate to appropriate.

**Problem Solving:**

**Conceptual definition:** “Problem solving is a practical skill that is fairly general, that could be learned, and that consists of four phases or principles: (a) understand the problem (the goal, what is known, what is not known), (b) devise a plan or solution approach, (c) implement the plan and confirm correctness of the implementation, and (d) examine the solution, confirm the result, and consider whether alternate solutions are possible.” (Polya, 1945)
**Operational definition:** problem solving in this study means responses to challenges of pupils to problems in their real life and helps the students to solve them.

**Scoring:** To measure this indicator, 5 questions close-answered based upon curriculum (science book) are prepared and questioned from students. Scoring is again based on five point Likert type scale.

**Reliability:** reliability analysis result shows that the Cronbach’s Alpha scale value is (0.91) for 5 questions, that is, there is reasonable internal consistency and cohesion in order to measure the variable of problem solving.

**Face validity:** In order to check the face validity of the instrument in terms of item coverage, item relevance and clarity of the items, an expert panel consists one expert in Research Methodologist, one belonging to Sociology department and one to Education department who were specialized in the field of Educational Psychology judged the validity of items, whether items are appropriate to the constructs “Problem Solving”, In order to determine and measure the validity of questionnaire were taken the views of teachers and experts in Educational Planners and Curriculum Programmer. The appropriateness of the item was sorted out on a 5 point scale ranging from very much to very low. (Very much, much, moderate, low, very low) .The items of the test were judged by the experts mostly ranged from very appropriate to appropriate.

**Team-Collaboration:**

**Conceptual definition:** “When a group of autonomous stakeholders of a problem domain engage in an interactive process, using shared rules, norms, and structures, to act or decide on issues related to that domain is called team- collaboration.” (kateen et al, 2011).

**Operational definition:** In this research team-collaborating means some of students as a team engage and work together and each of the members cooperate with the teammate, in order to explore ideas and to reach themes of the project.

**Scoring:** To measure this indicator, 5 questions close-answered based upon curriculum (science book) are prepared and questioned from students. Scoring based on five points the Likert type.
Reliability: Reliability analysis result shows that the Cronbach’s Alpha scale value is (0.95) for 5 questions, that is, there is reasonable internal consistency and cohesion in order to measure the team-collaboration variable.

Face validity: In order to check the face validity of the instrument in terms of item coverage, item relevance and clarity of the items, an expert panel consists one expert in Research Methodologist, one belonging to Sociology department and one to Education department who were specialized in the field of Educational Psychology judged the validity of items, whether items are appropriate to the constructs “Team-Collaboration”, In order to determine and measure the validity of questionnaire were taken the views of teachers and experts in Educational Planners and Curriculum Programmer. The appropriateness of the item was sorted out on a 5 point scale ranging from very much to very low. (Very much, much, moderate, low, very low) .The items of the test were judged by the experts mostly ranged from very appropriate to appropriate.

Under-graduate students:
Operational definition: in this study, Under-graduate students consists students of last grade in primary school in IRAN.

3.6. PROCEDURE:
In each class, the first session was confirmed of familiarizing and introducing researcher and student with each other and the teachers, and then students responded to a pre-test questionnaire which included 20 questions (5 question covered thinking skills, 5 question creativity, 5 question problem solving & the last 5 question team-collaborating). In the questionnaire each question is made assessment of a criterion skill. It’s necessary to mention that material was changed in the second’s lesson in science book. In the first lesson, students learnt about materials, molecules, and how to set molecules, and familiarity with scientific methods included: observation, classification, combination, analysis and conclusion.

The students that participated in this research belonged to fifth grade in science course. Because the study of science is based on exploration and investigation, many opportunities exist in the science classroom for project-based learning. Students work together to come up with experiments to answer simple or complex scientific questions, or they may explore alternative solutions to everyday problems.
In order to implement PBL to the experimental group, the researcher started with creating challenge in the minds of pupils. For example what are problems that you face with them daily? Have you ever thought to solve the problems? Some of children responded with bigger problems for instance air pollution, traffic jam etc. Small issues for example the frozen streets after snowing, lack of the bridge overpass and so on. The purpose was to explore what pupils can think about problems & issues with their teammates and note them. We encourage pupils to brain storming and to think about surrounding and pay attention to issues that exists in environment of their real life, in continuing, students have been teaming into 4 or 5 people in each team. Some of pupils had some questions about the method that is responded them. The researcher explained for student, what’s purpose of this instruction method (PBL) and how does it work. In all of time (6 sessions) students were working with each other in the laboratory or free space (park is named ALAVI’s BOOSTAN). Over there was a suitable space for student to can experience material changes, each team should 5 cases make change in material and noted their observations & experiences and classify into two ranges (physical change & chemical change).

In the next session the researcher tried to guide the attention of students to the main course (material changes) therefore some questions about it. Now every team engaged, consulted and discussed together. The researcher joined with them, in order to lead pupils to be situated on the itinerary of project, patterned questions such as: how do you solve the problems? For example one of pupils responded I can to solve a problem when the streets frozen I would sprinkle salt and sand on them, it help to melt snows as soon as possible. Why was the snow melt? They responded different and to my scattering question. What happen when you scatter salt and sand on the snow? Students were motivated to think about more examples in their real life and search about it, note results of their finding for the next session.

In the third session, the class was formed in free space (ALAVI Park). Over there was a space very appropriate and interesting for students to experience material change. In the beginning class, students organized their teams and got ready for collaboration. Each team sitting placed at long distance. Each team should 5 cases make change in material, and noted their observations and experiences, then to classify into two ranges (physical & chemical changes). The students argued, reasoned as to why the bread after sometimes to changed mould (fusty), and or why the fruits and vegetables after long time become wrinkled? Every team engaged and discussed the problem that was defined as a project, for example a team made a fire and
burned some woods that were turning into coal. The teammate were discussing with each other what’s happened to the wood?

Other projects that the students designed and were thinking about consisted of: clay molded into a new shape. Is it physical or chemical change? Why? What happen to your body after eating the food? Why does water evaporate from the surface of the oceans? Where does the weight go when we lose weight? What happens when iron rusts? Why do the leaves of trees in autumn (fall) turn yellow? How to make dough for making bread?

In the next session, the teams extended quality and quantity discussions. Now, they know how to engage with each other and plan the problem and solve it. How can to collaborate as a teammate. The researcher went from team to another team during their collaborative time, she posed questions to designing an experimental procedure, and all teams were able to create their own procedure, to examine the effects of material change on their life, although the procedure varied in quality and details. Some of children didn’t discover what are the reasons which lead to chemical and physical changes? Of course most of them know in physical change the shape and size of the object has changed. It wasn’t a change in the state of matter, but something changed, and they can cause physical changes with forces like motion, temperature, and pressure, and chemical changes happen between molecules and are unseen. When iron rusts we can see it happen over a long period of time. The actual molecules have changed their structure (the iron oxidized).and or melting a sugar cube is physical change, because the substance is still sugar. Burning a sugar cube is a chemical change. The energy of the fire has broken down the chemical bonds. Actually, the role of variables to create changes is vital, and pupils took it as a challenge and this was a great event to continue on PBL. To test the effects of different variables on the material was the next target for students. They had to record each variable such as temperature, humid and so on, to test in their experiments. The researcher explained a variable is anything that is different from the original, unaltered control sample, such as a change in heat. A variable could also be the addition of a foreign substance to your experiment.

During this study the students were working on material changes unit that was incorporated in project-based science. The goal of the project was for student to understand, integrate, engage, think, and solve their problem, to be creative and to work as a team member. In the last session, the researcher teaches power point software to students, to use in presenting in their final report. Finally students responded on same questionnaire pre-test. The researcher
requested the students to state the points of view about the instruction based on project. Three snapshot of the project’s plan can be seen under prefect overview.

**Administration: (pre-test and post-test)**

The experimental group consists of students who were selected in order to receive training on Project Based Learning. During the six sessions the classes, students had been engaged in Project-Based Learning. Before the PBL was introduced to the students (experimental and control groups) will be given pre-test(American based test) was given which consist of 4 questionnaires (thinking skills, creativity, problem solving and team-collaboration) in order to measure their initial abilities and after the completion of PBL post-test was found that their result was progressive. The analysis of data was done through by systematic random sampling technique.

It is an experimental research. This study aims to explore the effect of instruction method based on project based learning on the development of student's thinking skills.

**3.7. Statistical Techniques**

All the calculations were done on the computer with the help of a software package named as Statistical Package for Social sciences (SPSS) (version 18.0).

The analysis was done in two steps:

1. t-test.
2. Mann-Whitney U test

**t-test:**

A Mean is probably the most satisfactory measure for characterizing a group, it is important to determine whether the difference between Means of samples is significant.

The test of the significance of the difference between two Means is known as a t test. It is used to compare two Means.

Before applying this test the investigator made sure that the data were normally distributed. The basic statistics like Mean and Standard deviation were computed for each variable.

**Mann-Whitney U:**

A Mean is probably the most satisfactory measure for characterizing a group, it is important to determine whether the difference between Means of samples is significant.
The test of the significance of the difference between two Means is known as a t test. It is used to compare two Means.

Before applying this test the investigator made sure that the data were non-normally distributed.

**DELIMITATIONS**

One vital point observed by the researcher was the student’s inability to create scenarios for the PBS (project-based science). This may be due to the lack of course content emphasizing thinking skills such as creativity and problem solving. Additionally, the teachers don’t know how to write instructional scenario. Therefore, the curriculum should be evaluated and enhanced with courses emphasizing creativity and problem solving. This curriculum analysis will yield better results for PBS.

The limitations of this research are in its scope. We studied a small number of students working on within one project. We are limited in our ability to generalize about the patterns of challenges seekers and about how PBL in mathematics’ or other topics, might present academic challenges.