AN EXPERIMENTAL STUDY ON THE EFFECTIVENESS OF PROBLEM-BASED VERSUS LECTURE-BASED INSTRUCTIONAL STRATEGIES ON ACHIEVEMENT, RETENTION AND PROBLEM SOLVING CAPABILITIES IN SECONDARY SCHOOL GENERAL SCIENCE STUDENTS

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24 – SS/Ph.D(Edu)/03

DEPARTMENT OF EDUCATION

FACULTY OF SOCIAL SCIENCES

INTERNATIONAL ISLAMIC UNIVERSITY

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A thesis submitted in partial fulfillment of the requirement for the degree of

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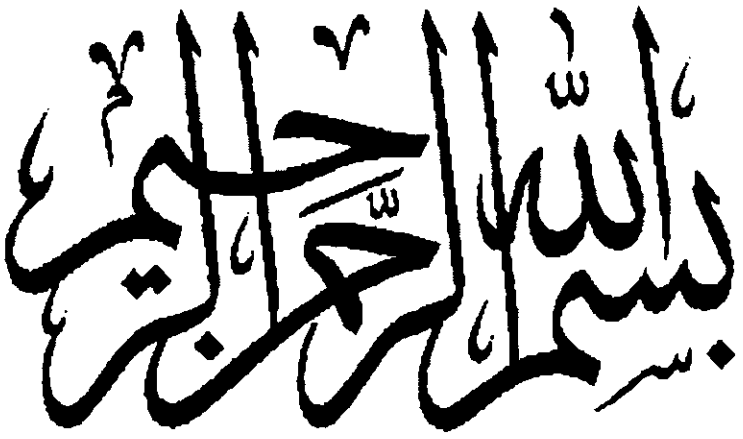

In the name of Allah,
The Beneficent, the merciful.

Dedicated

To

My parents and family

members

APPROVAL SHEET

AN EXPERIMENTAL STUDY ON THE EFFECTIVENESS OF PROBLEM-BASED VERSUS LECTURE-BASED INSTRUCTIONAL STRATEGIES ON ACHIEVEMENT, RETENTION AND PROBLEM SOLVING CAPABILITIES IN SECONDARY SCHOOL GENERAL SCIENCE STUDENTS

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SUPERVISOR'S CERTIFICATE

It is certified that the contents and form of thesis entitled" **An Experimental Study on the Effectiveness of Problem-based versus Lecture-based Instructional Strategies on Achievement, Retention and Problem Solving Capabilities in Secondary School General Science Student**" submitted by **Mr. Muhammad Nafees** registration No. **24-SS/Ph.D.(Edu)/03** have been found satisfactory for the requirement of degree.

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All praises to Almighty Allah alone, the omnipotent, the omnipresent, the most merciful and His Holy Prophet Muhammad (Peace be upon Him), the most perfect and exalted among all human beings ever born on surface of earth who is forever the torch of guidance and knowledge for humanity as a whole.

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ABSTRACT

Teaching methodology, such as problem-based instructional strategy, has arisen in response to educational research that has found evidence that even though lecturing may be the most prevalent teaching tool, it is less effective way to facilitate students learning. Problem-based instructional strategy is a teaching tool that teaches cooperative learning, grouping of students and an inquiry-based methodology for science education leading to better student learning, problem solving and retention.

The researcher therefore conducted this 12-week experimental study to find out the relative effectiveness of problem-based and lecture-based instructional strategies in teaching the subject of General Science at secondary school level in (a) academic achievement, (b) retention of subject matter and (c) problem solving capabilities. It was hypothesized that there is no significant difference existed in increased average academic achievement, improved problem solving capabilities and increased average retention of subject matter between the students taught through problem-based instructional strategy and lecture-based instructional strategy. The researcher used purposive sampling technique for the selection of participants of the study. The participants of this research study were the 9^{th} class male students in Islamabad district taken from Federal Government Boys Higher Secondary School, Rawat, Islamabad and Federal Government Boys High School, Sangjani, Islamabad. The sample from the former school consisted of 67 students (N=33, N=34) and from the latter school, 41 students (N=21, N=20).

For this study, pre-test post-test nonequivalent control group design was followed. Consequently, pretest, posttest and retention test were self developed and used as research instruments for measuring the variables of academic achievement, retention of subject matter and problem solving capabilities. Thus, the strategies were

the independent variables and academic achievement, problem solving capabilities and retention were the dependent variables.

The effect of problem-based instructional strategy was found out through its manipulation and was compared with the effect of lecture-based instructional strategy. The data were collected through administering the pre-test and post-test and were summarized by such descriptive statistics as mean and SD and analyzed by using such inferential statistics as *t*-test and Levene's test. The level of significance used to test study hypotheses was .05.

The results of the experiments conducted simultaneously in two secondary schools suggested that problem-based instructional strategy is not only more effective than lecture-based instructional strategy in facilitating increased average academic achievement of 9^{th} grade male students in the subject of general science but also in improved average problem solving capabilities and increased average retention.

It is recommended that faculty development programmes regarding problem-based instructional strategy may be started and implemented so that General Science teachers may be prepared and supported to engage in the use of problem-based instructional strategy. The science teachers may apply problem-based instructional strategy in the classroom instead of lecture-based instructional strategy and consequently the learning of the students may enhance. Problem-based instructional strategy may be applied at secondary school level in science subjects as it enhances the retention rate of the subject matter and problem solving capabilities of students which is more desirable in their practical life.

Similar studies be launched in other secondary school subjects and at other levels of education so as to generalize the results of this study.

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ABBREVIATIONS

Dy	Deputy
Dr.	Doctor
FA	Federal Area
FG	Federal Government
FGBHS	Federal Government Boys High School
FGBHSS	Federal Government Boys Higher Secondary School
IS	Instructional Strategy
LBIS	Lecture-based Instructional Strategy
NEAS	National Educational Assessment System
PBL	Problem-based Learning
PBIS	Problem-based Instructional Strategy

CHAPTER 1

1.1 INTRODUCTION

Education is a process of developing self-consciousness among human beings. It is a vital tool for human resource development and a necessary element for sustainable socio-economic growth. It is not simply providing instruction to the children but in fact it is the significant social process that serves for mental, physical, ideological, and moral development of young generation to empower them to realize their roles in practical lives.

Islam lays down emphasis on the importance of knowledge and the role of teacher. A professionally qualified teacher can stimulate the internal curiosity of the students, and can develop thinking ability among them. Now a days educationists also stress restructuring the classroom environment to make it effective for learning.

Recently in classrooms, teachers are focusing on student activities but still most of them adopt the style which is teacher centered in which teacher has the main role in teaching/learning process. The teacher speaks in front of a class and the students listen to him or her and memorize the facts they receive from the teacher in the form of classroom notes. There is a great need to change this type of teaching strategy so that we can help our students to take deep level approach to their learning and can be trained to become independent lifelong active learners.

Many recent reform initiatives involve shifting the focus of classroom environment from the teacher to the student (Mizrachi, 2010). Engaging students through in-class activities can engender this shift in classroom environment.

A teacher can use more than one instructional strategy in a classroom to teach the students. These instructional strategies are mainly selected keeping in view the learning objectives already set by the course developers. In many cases, a combination of instructional strategies is used to strengthen the learning experiences of the students. These instructional strategies are used in the lesson to ensure the sequence and delivery of the instruction.

The selection of proper instructional strategy ensures the achievement of the prescribed instructional objectives effectively. Mizrachi (2010), described that the effectiveness of instructional strategies depends upon the achievement of particular objectives being set. It is a process by which an entire course, an instructional phase, or an instructional module is delivered.

Current research studies suggest that the effective learning occurs through presentation of problems that are related to the existing situations. These studies further explain that learning is a complex activity, and it demands for comprehensive approaches to instruction for effective learning. This understanding has given rise to the new concept in education in which more focus is on learning rather than teaching (Barr and Tagg, 1995). New instructional strategies such as project-based learning, inquiry-based learning and problem-based learning (PBL) have emphasized 'learning' and are gaining prominence in classroom practices.

Problem based instructional strategy (PBIS) is based on a specific problems. These problems are related to real life and require some sort of efforts for their solution. Apart from solving the problems, the students have to find the information and other resources for future needs. In problem-based Instructional strategy, students work in

groups; share information and knowledge and help each other to arrive at solution to the problem. In PBIS, the students are graded on the basis of what they do rather than what they remember (Barr and Tagg, 1995).

Problem-based instructional strategy (PBIS) is an instructional strategy in which complex problems stimulate the student for learning. The students have to solve the complex "real world" problems presented to them through teamwork. In PBIS, skills like collecting, evaluating and synthesizing the relevant information are developed in them so that they can define and propose a solution to the given problem.

Problem-based instructional strategy has been advocated by teachers as an instructional strategy that can help students acquire creative thinking and lifelong learning skills. Therefore, it is important for teachers to pay full attention to the content knowledge and teach content to students in such a way that it would not become obsolete. Today's critical thinking and lifelong learning skills are the most important skills needed to survive in a knowledgeable and changing society. Teachers need to reflect on current educational practice and adapt themselves to new challenges that will equip students with problem solving, critical thinking, and lifelong learning skills. Problem-based instructional environment enables students to develop problem solving skills as well as the necessary knowledge to be learned in the subject content. In problem-based instructional environment, the students learn both content and critical thinking skills in the process of solving actual problems.

In formal education, lecture-based instructional strategy has dominated as an instructional strategy for providing information and knowledge over the centuries. This strategy has been used to convey a lot of information and knowledge to large groups in

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In formal education, lecture-based instructional strategy has dominated as an instructional strategy for providing information and knowledge over the centuries. This strategy has been used to convey a lot of information and knowledge to large groups in

comparatively short time. In lecture-based instructional strategy, these large groups are kept on same point together in a class as compared to other instructional strategies. Perhaps the main advantage of lecture-based instructional strategy is that, in the hands of an enthusiastic teacher, it can be an effective vehicle to communicate students with a spirit and love for the subject.

According to Bloom (1956), comprehension of the students is not properly checked through lecture-based instructional strategy. In this strategy, the speaker continues his talk most of the time and least allows the students in verbal participation during the lecture. In lecture-based instructional strategy, students faced difficulty in determining about what is the most important part of the lecture for preparation of exams because the course content is frequently presented in an uneven and an unorganized manner.

Apart from that, in lecture-based instructional strategy, the students are more passive learner in the learning process. The students listen to the information, take notes, and then recall the information at the time of evaluation (Bligh, 2000). This strategy focuses more on acquisition of information and knowledge rather than on understanding, retention and problem solving.

In today's society, there is a need to foster creative thinking and lifelong learning skills. New instructional pedagogies such as project-based learning, action learning, inquiry-based learning and problem-based learning have been developed and used in different educational setting to foster these skills. Among them problem-based instructional strategy has gained in popularity across various subjects such as engineering, medical, law, business studies, and education. Various studies were

conducted on problem-based instructional strategy in West but there is lack of research on this topic in Pakistan. These circumstances provided an excellent opportunity for the researcher to conduct research and compare the effectiveness of problem-based instructional strategy and lecture-based instructional strategy on students: 1) academic achievement; 2) problem solving capabilities; and 3) retention of subject matter.

1.2 STATEMENT OF THE PROBLEM

This experimental study was designed to determine which instructional strategy, problem-based or lecture-based, is more effective in teaching the subject of General Science at secondary school level and which strategy produces higher level of academic achievement, better retention rate among the students, and better student problem solving capabilities.

1.3 OBJECTIVES OF THE STUDY

Following were the objectives of the study:

1. To measure academic achievement and problem solving capabilities of selected intact classes before the experiment.
2. To measure academic achievement, problem solving capabilities and retention of the experimental group and control group after providing treatment of problem-based instructional strategy and lecture-based instructional strategy respectively to each comparison group.
3. To compare the effectiveness of problem-based instructional strategy and lecture-based instructional strategy in terms of academic achievement of secondary school students.

4. To compare the effectiveness of problem-based instructional strategy and lecture-based instructional strategy in terms of development of problem solving capabilities among secondary school students.
5. To determine the comparative effectiveness of problem-based instructional strategy and lecture-based instructional strategy in terms of enhancement of retention of the subject matter among the secondary school students.

1.4 HYPOTHESES OF THE STUDY

To achieve the objectives, following null hypothesis were formulated and tested:

$H_0$1: There is no significant difference between the mean pre-test academic achievement scores of the students to be taught through problem-based instructional strategy and the students to be taught through lecture-based instructional strategy.

$H_0$2: There is no significant difference between the mean pre-test problem solving capabilities scores of the students to be taught through problem-based instructional strategy and the students to be taught through lecture-based instructional strategy.

$H_0$3: There is no significant difference between the mean post-test academic achievement scores of the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy.

$H_0$4: There is no significant difference between the mean post-test problem solving capabilities scores of the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy.

H_o5: There is no significant difference between the mean retention posttest scores of the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy.

1.5 SIGNIFICANCE OF THE STUDY

The study would be significant in the following ways:

The study was experimental trial of teaching the subject of "General Science" through problem-based instructional strategy. It would provide base for change in the prevailing teaching practices through comparing the effectiveness of problem-based instructional strategy (PBIS) and lecture-based instructional strategy (LBIS). This study, therefore, would provide the evidence based effective teaching strategy that can be availed by the educational managers and practitioners to adopt procedure to achieve desired learning outcomes in the subject of "General Science".

There are certain reservations of the educationists that current instructional strategies are not supportive of the desired results and the students are not prepared for their practical life that requires problem solving skills. The researcher has considered the same point of view and applied problem-based instructional strategy to achieve the purpose.

This is the age of science and technology in which different problems emerge in our daily life; hence the instructional system should cope with this dire need of the students through application of different classroom practices that are research based.

This study would explain the current pedagogical practices with its merits and demerits and suggest the efficient and effective instructional strategy that would ensure the quality of product in terms of the demands of the society and market as well.

This study would also be helpful to orientate the curricula, which should contain problem solving activities that would develop critical thinking and problem solving capabilities among the students.

Further the study would guide for appropriate content selection and its presentation in such a way that would ensure the active participation of the learners through engaging them in problem solving activities. The results of this study may guide the direction of future research in this vital area.

1.6 METHOD OF THE STUDY

1.6.1 Population of the Study

The population of this study consisted of 6303 male students of 9th class studying in 53 schools in Islamabad district during the session 2008 – 09.

1.6.2 Sample of the Study

The researcher selected two male secondary schools for this research study. Each school had two 9th class sections of teaching "General Science". So those sections were taken as intact groups to participate in this study. One section in each school was for problem-based instructional strategy and the other in each school was for lecture-based instructional strategy. A total of 108 students participated in this study.

1.6.3 Design of Study

A Pretest-Posttest Non-equivalent Control Group Design was employed to measure the differences in academic achievement, retention rate of subject matter and problem solving capabilities of students taught through problem-based instructional

strategy and the students taught through lecture-based instructional strategy at secondary school level.

1.6.4 Research Instruments and material

The researcher developed three different types of test to measure the dependent variables:

1. Achievement Test (AT)
2. Problem Solving Capabilities Test (PSCT)
3. Retention Test (RT)

The first test was used to measure the academic achievement of the students while the second one was used for problem solving capabilities among the secondary school students. The academic achievement test (Appendix III) consisted of 80 multiple-choice questions (MCQ's) and was used as pretest to determine the prior knowledge of the students. The achievement test was also used as the posttest administered immediately after the treatment period was over. The retention test (Appendix V) administered after three months of the posttest by reorganizing the achievement test items. The problem solving capabilities test (Appendix IV) consisted of 15 real-world problems.

Two versions of lesson plans were used, one based on lecture-based instruction (Appendix I) and the other based on problem-based instruction (Appendix II).

1.6.5 Data Collection

After three months of experimentation, data were collected through researcher made tests for academic achievement, retention of subject matter and problem solving capabilities.

1.6.6 Data Analysis

Data was analyzed to test the hypotheses. Mean, standard deviation, and variance of mean pretest and posttest scores were obtained. The significance of difference between the means of experimental and control groups was measured by applying independent sample *t*-test.

1.7 DELIMITATIONS OF THE STUDY

The study was delimited to the 9th class students in:

1. Federal Government Boys Higher Secondary School, Rawat, Islamabad and Federal Government Boys High School, Sangjani, Islamabad.
2. Only four chapters were included from the textbook of "General Science" recommended by Federal Board of Intermediate and Secondary Education, Islamabad. These were "Our life and Chemistry" (Chapter 2), "Microorganism and Diseases" (Chapter 5), "Energy" (Chapter 7), and "Basic Electronics" (Chapter 9).

CHAPTER 2

REVIEW OF RELATED LITERATURE

The overall objective of this study was to compare the effectiveness of problem-based instructional strategy and lecture-based instructional strategy. For this purpose, the review in this chapter is divided into two parts:

1. Conceptual / Theoretical framework
2. Research Studies

In the first part, a brief review of the current understanding of lecture-based instructional strategy and problem-based instructional strategy is provided. This is followed by an overview of the definition and design attributes of problem-based instructional strategy.

The second part of this chapter is dedicated to an analysis of the research findings published to date in the world on the impact and effectiveness of problem-based instructional strategy on students' academic achievement, attitudes, problem solving, and meta-cognitive development and the need for research on the teaching and learning of problem-based instructional strategy.

2.1 INSTRUCTIONAL STRATEGY

Instruction is the way of helping students to learn. In schooling it is mostly associated with teaching. It is the creation and use of environments in which learning is facilitated. (Alessi & Trollip, 2001)

According to Saxena and Oberori (1994), the term strategy means to outline some acts that serve to achieve positive outcomes and to safeguard against others. They pointed out that the instructional strategy contains all the aspects like subject matter, task analysis, teaching objectives, the desired and expected changes in the behavior of the learners, their attitude, abilities, capacities, needs and entering behavior etc. The instructional strategy also includes educational philosophy, learning principles, instructional objectives, feedback about the desired activities and motivational procedures.

Instructional strategy (IS) is an educational approach that turns the knowledge into learning. It is the process by which an instructional unit, instructional point or an entire course is delivered.

Saxena and Oberori (1994) pointed out that there are two types of instructional strategies:

1- Autocratic Strategies

2- Democratic Strategies

Autocratic strategies are also called as traditional teaching strategies. These strategies are content centered and teacher centered in which the role of teacher is active while that of the student is passive one. The autocratic strategies commonly include lecture-based instructional strategy, demonstration, tutorial, programmed instruction and computer aided instruction and learning.

The democratic strategies are the most recent teaching strategies. In contrast to autocratic strategies, these are student centered in which a student is active one while the

teacher works as a facilitator to the students. These strategies include problem solving, project-based and activity based instruction etc.

Oliva (1997) described that the instructional strategy is hypothesized as having both the:

1. Teaching activities that a teacher has to perform
2. Learning experiences that a learner has to achieve

He further stated that instructional strategy largely includes methods, procedures and techniques. The instructional strategy is used by the teachers to present content to the students for bringing about the desired learning outcomes. According to him, the common instructional strategies are lecture-based instructional strategy, independent study, laboratory work, inductive and deductive methods, tutoring, small group discussion and inquiry or discovery methods. He gave a guideline for the selection of instructional strategy and proposed that the strategy must be suitable for the student and it must fulfill the needs and interest of the students. Then, it must be for the individual teacher, the content, the availability of time, the available resources, the facilities and finally the objectives.

2.2 LECTURE-BASED INSTRUCTIONAL STRATEGY

The most commonly used strategy in education is the lecture-based instructional strategy. It is the oldest instructional strategy given by the philosophy of idealism. The word "lecture" is derived from the Latin legere means, "to read." Swanson and Torraco (1995) stated that the lecture-based instructional strategy was started centuries ago as a teaching/learning process. In this strategy, the teacher begins to read an important passage of the lesson before the students and then interpret that passage for their

comprehension. In education, the main emphasis of lecture-based instructional strategy is on the penetration of content and is used for the clarification of some major ideas of the students.

According to Uden, L. & Beaumont, C. (2006), in lecture-based instructional strategy, the students are expected to sit quietly, listen to the teacher and take notes of the lecture presented to them. The teacher alone provides information to the large group of students. In typical lecture-based classrooms, the students seem to be in prison, passive and bored audience waited for the information from the teacher during the whole lecture. Due to this reason, lecture-based instructional strategy lacks interaction between teacher and students and between students themselves. Teacher remains active during the whole class period and provides information and knowledge to the students related to the prescribed course structure of the textbook. In this strategy, it is generally accepted that the students have to know the subject content that the teacher provides to them. The information is often provided in discrete parts that finally build into a whole concept. The main objective of the teacher in this strategy is to provide information and knowledge to the passive students. The learning goal in this strategy is the reiteration of accepted explanation of the course content expostulated by the teacher.

However, by using question/answer techniques, the teacher can keep them attentive in the class. Lecture is primarily used to transfer information from the teacher to the student. So, it is a good idea to clearly state the purpose of the lecture before developing the content of the lecture. The purpose should describe in general terms what the students will learn during the lecture.

According to Vella (2006), lecture-based instructional strategy is the formal presentation of the content by the teacher as a subject expert for ensuing learning and recall in the examination by the students.

Ruyle (1995) describes that the lecture-based instructional strategy is an oral presentation of the instructional material or content. This strategy is commonly used to motivate, clarify, expand and review the information presented to the students.

2.2.1 COMPONENTS OF LECTURE-BASED INSTRUCTIONAL STRATEGY

According to Silberman (2006), there are five major components of lecture-based instructional strategy to maximizing the understanding of the students. These components can be used to ensure the effective transfer of knowledge to the students.

1. **Opening Summary:** Presenting major points and conclusions at the start of the lecture can help the students in organizing their listening skills.
2. **Present key Terms:** During the lecture, use key terms instead of major points that will help the students in retaining the verbal subheading.
3. **Offer Examples:** When possible, present real-life examples of the ideas to the students in the lecture.
4. **Use Analogies:** If possible, make the comparison between the knowledge of the students they already have and the content of the lecture.
5. **Use Visual Backups:** Using the variety of visual media enables the students to hear and see what is being said and what is being shown to them.

Lecture can be made effective by breaking down the component parts of the lecture and then using variety of approaches within each component. In lecture-based instructional strategy, students often attended a series of lectures delivered by the same

teacher. So, the teachers have to keep in mind that the students learn best of what he delivered to them if he uses different approaches during lecture in an effective way. Introduction, body and summary are the three main parts of lecture-based instructional strategy.

In a lecture, introductory part is used to develop interest and attention of the students towards lesson. This part also creates positive learning climate and encourages students to learn. It also makes students aware of the expectations of the teacher for the lesson. A good introduction can make the lesson more effective and interesting and is critical to the success of the lecture.

Once the students have developed their attention towards the lesson with an interesting introduction, the teacher can then smoothly move towards the body of the lecture. This part of the lecture contains the core of information and knowledge which needs to be transmitted to the students by the teacher. Beitz (1994) recommended that teacher use different activities such as brainstorming, problem solving, discussion, games and case studies to make the lecture more effective, interactive and interesting.

The purpose of summary is to illustrate briefly together the critical information and knowledge presented by the teacher and to make guarantee that the students have a clear understanding of the information provided to them by the teacher. A lecture can be summarized by using various techniques such as asking questions to the students by the teacher, asking questions to the teacher by the students and using slides or flipcharts to review the main points of the lecture.

2.2.2 ADVANTAGES OF LECTURE-BASED INSTRUCTIONAL STRATEGY

Although lecture-based instructional strategy is considered to be an old-fashioned and unsuccessful way of presenting information, yet it offers a number of advantages and reasons for its persistent use in delivering of information (Barbetta & Scaruppa, 1995; Michael, 1994). Jones, D. (2003) stated following advantages of lecture-based instructional strategy.

1. Lecture-based instructional strategy is used to present many facts or ideas in reasonably short time. It is the most effective method of teaching through which the content has been logically planned and presented succinctly in a rapid sequence.
2. Lecture-based instructional strategy is acutely appropriate in introducing a new subject or a course of study. Basic information about a subject can be presented in a lecture to ensure that all the students have necessary background knowledge of the subject they are going to study. In this way, students coming with various backgrounds develop in them common understanding about the subject.
3. A brief introductory lecture can prepare students for a discussion or give direction to the students for further study.
4. Lecturing is versatile because any subject area can be taught through lecture. A lecture can last from a few minutes to several hours.
5. Lecture-based instructional strategy is also useful in improving the information and knowledge difficult to obtain. In some subjects where there is scattered information, only the lecture helps the teacher run through the related material. Now a days, information changes regularly and this information may not be

available in written form, only the lecture provides up-to-date information to the students.

6. A large number of students can accrue benefit from the expert on the subject through lecture-based instructional strategy. A teacher can share his actual experiences with the large gathering of students.
7. An enthusiastic teacher can motivate his students by making his lesson most effective way of communication.
8. The teacher's enthusiasm and commitment to the subject in a lecture motivate the students to listen attentively and learns the lesson positively.

2.2.3 LIMITATIONS OF LECTURE-BASED INSTRUCTIONAL STRATEGY

Although the LBIS has many advantages and is proved as an effective and efficient instructional strategy yet it has many limitations. Jones, D. (1996) summarized the following limitations of lecture-based instructional strategy:

1. In certain type of learning a subject, lecture-based instructional strategy does not guide the students to maximum achievement. Speech skills, group thinking and motor skills are very tricky to teach with this method because such skills can only be developed through practice and lecture-based instructional strategy lacks this phenomenon.
2. Another problem associated with lecture-based instructional strategy is that the information presented to the students is often detached from the real-world cases. The information and knowledge is presented as context independent. There is evidence that unless students learn something in a way that includes an understanding of its significance or function, they may experience restricted

access, even when applicable situation arises. This is generally referred to as a transfer problem or the problem of inert knowledge.

3. Lecture-based instructional strategy is generally not suitable for teaching the lesson that is above the comprehension level of the cognitive domain so the understanding of the students is not checked through this strategy.
4. Lecture-based instructional strategy is the one-way process of teaching and it does not allow students in verbal participation during the lecture.
5. In a lecture, course content is often presented in unorganized and uneven fashion. This makes it difficult for students to determine the most important aspects of the lecture (i.e., what's going to be on the exam?).
6. This strategy does not provide teachers with an opportunity to guess the progress of the students before the start of examination.
7. In a single lecture, a teacher can unintentionally present more information than the students can absorb.
8. The listening, language, or motor skill deficits of some students with disabilities make it difficult for them to identify important lecture content and write it down correctly and quickly enough during a lecture. While writing one concept in his notebook, the student with learning disabilities might miss the next two points (Hughes & Suritsky, 1994).
9. In this instructional strategy, determining the learning level of the students is very difficult for the teacher during the lecture.
10. In lecture-based instructional strategy the student's participation in the lecture is very little and the teacher has to do all the work. As a result, this strategy

promotes passiveness in the students and they rely much on the teacher. Lacking interaction between the teacher and the students is also a major limitation of this strategy.

11. This strategy is time consuming, as the teacher has to spend much time on the preparation of the lecture.
12. In this strategy, it is very difficult for the teacher to hold the attention of the whole class during the lecture. Effectiveness of lecture-based instructional strategy needs significant skills in speaking.

2.2.4 ROLE OF THE TEACHER IN LBIS

All researches on effective teaching practices address the role of the teacher in presenting lessons. Rosenshine and Stevens (1986) have called the role of the teacher in presenting the content as lecture. According to them, lecture is like an effective demonstration in which the teacher is clear about the goals and main points of the information being presented. The teacher stated the goals or objectives of the presentation beforehand. In a lecture the focus of the teacher is on one thought at a time. They further stated that teacher should avoid digressions and ambiguous phrases and pronouns in a lecture to make it more effective and interesting for students.

The teacher presents content sequentially. He organizes and presents the material in small steps so that one point is mastered before the next point is given, gives explicit, step-by-step directions, and presents an outline when the material is complex.

The teacher remains content specific in a lecture. He delivers the information and knowledge with full control and provides explanation of difficult terms and key points with concrete examples.

The teacher evaluates the understanding of the students about the information and knowledge being presented to them before moving on to the next point. He wanted to be sure that the students understand the key points presented to them. He asks different questions relating to the information to keep an eye on their comprehension. The teacher also engage the students to recapitulate the main points in their own words and finally re-teach the lesson by further explanation of the difficult points so that the students may not have any difficulty in comprehending the lesson.

2.2.5 PRINCIPLES OF AN EFFECTIVE LECTURE

A teacher can refine his lecture and make his lecture as effective as possible by paying attention to a few basic principles. These basic principles are:

1. Do not speak continuously for more than 15 minutes. A few studies have shown that the attention span of the passive students is roughly 15 to 20 minutes. So those listeners, who are not involved in the process of listening, lose concentration. They may continue to take notes, but they do not perceive the information in the way that it becomes a part of their learning.
2. Ask questions to the students or interact with them through two-way communication. This will involve the students in the teaching learning process. Some researchers have discovered that in a lecture-based instructional strategy, the interaction between teacher and students through question/answer style keep the students active during the entire class period.
3. During the lecture, provide important cues to the students for discriminating between more important and less important material. In lecture-based

instructional strategy, students face problem of audience attention when they receive information and knowledge aurally. It is important for teachers to give them appropriate cues so that they can easily discriminate between more important and less important material in a lecture.

4. Constantly verify the perceived information and knowledge of the students through eye contact. In a lecture-based instructional strategy, one-way communication can cause problem with audience perception of the information being sent to them.

5. Another principle of an effective lecture is to provide links using metaphors between new knowledge or information with the previous learning or experiences. Students faced problem in learning or receiving new information and knowledge which is unrelated to previous learning or experiences. There is evidence that students learn best by subsuming new knowledge and information under pre-existing categories in our cognitive structure. Researchers have suggested that an effective teacher has developed the trait of constructing metaphors that immediately connect new ideas, information and knowledge with the minds of the students.

6. The sixth principle of an effective lecture is the illustration of new concepts with the help of concrete examples. Visual representation of complex ideas makes the lesson easy and understandable to the students. Concrete examples help students to conceive new concepts and understand new processes by relating them to the pre-existing fields of memory.

7. It is best to provide blank time to students during a lecture. This can be done through internal summaries, anecdotes, and illustrative material. Students will be able to process new information if blank time is provided to them. In short-term memory, an individual can hold only seven chunks of information. Some chunks will inevitably be lost if more new information is received before the encoding process of previous information can take place. In a lecture, when students receive new information continuously, they do not get enough time to encode that information for storing it in long-term memory. The students only take notes to record that information. In order to learn best from a lecture, the students should be provided blank time in which no new information is being presented to them, so that the coding process can take place easily. (Davis, B. G., 1993)

2.3 PROBLEM-BASED INSTRUCTIONAL STRATEGY

Problem-based instructional strategy (PBIS) has now emerged as a well-established instructional strategy. A lot of literature is now available on development and implementation of this instructional strategy. Students find more relevant material and benefit more when they taught through problem-based instructional strategy.

Most of the teachers showed their concern and dissatisfaction on lecture-based instructional strategy so they repeatedly quoted for the implementation of problem-based instructional strategy. Lecture-based instructional strategy is now under continuous scrutiny, increased pressure and criticism which led the institutions and teachers to adopt problem-based instructional strategy as a new strategy. Now there is rapid explosion of literature about problem-based instructional strategy, which creates concern about the concept of problem-based instructional strategy. The teachers are often confused in using

and implementing PBIS as an instructional strategy because they considered any strategy as PBIS which mentioned the word "Problem". This led to the debates about the concept of PBIS to think that what is pure "PBIS" and what is not.

According to Stepien & Gallagher (1993), problem-based instructional strategy is a strategy of curriculum development that stresses the need to develop problem solving skills and help the students to get their hands on knowledge, information and skills.

Merrill (2001) described that problem-based instructional strategy is a strategy in which complex, real-world problems are presented to the students. These problems are well thought out and do not have one specific right answer or fixed outcome. In this strategy, students recognize the researchable areas of the problem, develop hypothesis, confer on an acceptable solution of the problem by working together in small groups and finally present that solution of the problem to other students.

Esch (1998) described that problem-based instructional strategy is a student centered strategy in which students worked in cooperative groups for unlimited period of time. The students are affianced in problem-based learning and look for various sources of information to congregate knowledge and solution to the problem. In this strategy, the role of teacher changes from dispenser of knowledge to facilitator or coach.

According to Finkle & Torp (1995), problem-based instructional strategy is an instructional strategy in which multifaceted and chaotic problems are given to the students. These problems are ill-structured in nature and require investigation, gathering of information and have no simple, fixed, one right answer to the problem.

Operational definition:

Problem-based instructional strategy is a strategy that allows students to work together in groups for solving real-world problems. This strategy put emphasis on problem solving, critical thinking and lifelong learning in developing educational skills that enables the students to survive in a competitive and changing world.

Problem-based instructional strategy (PBIS) is a student centered instructional strategy in which carefully crafted problems are used to teach the content and skills. This strategy empowers students to find solutions to the problems by themselves rather than by learning through lectures. In problem-based instructional strategy, students learn by connecting problem to daily life and develop the use of problem solving and critical thinking skills for the solution of the problems.

2.3.1 HISTORY OF PROBLEM-BASED INSTRUCTIONAL STRATEGY

According to Amador, J. A., Miles, L., and Peters, C. B. (2006), problem-based instructional strategy (PBIS) was originally planned for graduate medical school program at Case Western Reserve University in the United States (1950s) and McMaster University in Canada (1960s) when teachers noted that the students were graduating with lot of information but they could not use that information and knowledge wisely to solve the problems they were facing in their daily life. Through PBIS medical education, students are helped to learn the basic biomedical science knowledge and skills by dealing with authentic medical cases. When PBIS emerged as an instructional strategy, it gained in popularity across various subjects such as engineering, medical, law, business studies, and education. As a result, in 1969 a medical school was found in Ontario with an educational philosophy called "McMaster Philosophy" which had later evolved into an

instructional strategy known as problem-based instructional strategy. (Uden, L. & Beaumont, C., 2006)

After 1990's, PBIS became an increasingly popular instructional strategy of learning in higher and further education. Now a day, this instructional strategy is also used in education. This strategy requires the students to learn by engaging themselves in authentic problem solving. In this instructional strategy, the basic unit of instruction is project and this project is implanted with a well-defined problem that is somewhat content specific (Dods, 1997). PBIS learning involves both knowing and doing and only problems, which are realistic and relevant in nature and situation, lure students to become actively engaged in their solution. This instructional strategy enables students to learn their subject and to gain the high-level competencies and complexity skills.

2.3.2 TYPES OF PBIS TAXONOMY

According to Barrows (1986), problem-based instructional strategy has different variations. Some commonly variations referred to by teachers as problem-based instructional strategy are given on next page.

1. Learner-based Cases
2. Case-based Lectures
3. Case Method
4. Project-based learning
5. Action Learning
6. Problem-based

2.3.2.1 Learner-based Cases

In learner-based cases, teachers present information to the students in lecturers. One or two cases are presented to demonstrate the relevance of the information. When teachers use learner-based cases during their teaching, it is referred as problem-based instructional strategy. However, it does not foster the skill required for problem-based instructional strategy. Students understand the case presented to them in the form of information during the lecture. In learner-based cases, students may restructure the information through some hypothesis development, data gathering, data analyzing and limited decision making but there are not any inquiry or case building skill involved.

2.3.2.2 Case-based Lectures

In this method one or more complete case histories are presented to the students before the lecture. The covered material is highlighted by the cases. The students used their prior knowledge and analyze the cases before any new knowledge is provided to them. This effect causes some oriented structuring of information provided in lecture as opposed to possible restructuring of information already provided.

2.3.2.3 Case Method

This method is used in business and law education. A complete case of study is given to the students and then class discussion is scheduled on subsequent class. The teacher discusses the subsequent interactive case by combining both student-directed and teacher-directed learning. In this method more active structuring of information is done due to stronger development of hypothesis, data analysis and decision making. That is why this method is more motivating although limited amount of reasoning is occurred.

2.3.2.4 Project-based learning

There is some confusion between the terms of problem-based learning and project-based learning. These two terms share many similarities. The focus of learning is problems or projects in both these approaches. Students enhance learning in both approaches through engagement in real world tasks. Both methods adopted the approach of student-centered and the teacher works as facilitator or coach. Students work in groups and the assessment is done through peer-based, performance-based and authentic.

As far as the differences are concerned, project-based learning begins with end product in mind which requires specific content knowledge and skill. Project-based learning raises one or more problems that students must solve. Production model is typically used by the students in project-based learning. It consists of:

1. Identify the purpose for the creation of the end product;
2. Research the topic;
3. Design the product;
4. Create a plan for project management. (Esch, 2000)

The project is then started by the students. They resolve the problems and issues in production and finish the product. The end product is based on real world production activities and is supposed to be authentic. This end product is the driving force in project-based learning. Students use their own ideas to accomplish the tasks in project-based learning. They are given time to evaluate their work. The success of project-based learning depends upon both the content and knowledge acquired during production process.

2.3.2.5 Action Learning

According to Atherton, J. S. (2009), action Learning is a form of problem-based instructional strategy. In action learning no one knows the answer of the real-world problem being presented to them.

Revans (1982) has worked out on action learning and found that it is a specific process for workplace-based professional development. Action Learning implies both self-development and organization development. The main objective of action learning is not just answering questions defined by the teacher but it is to learn how to ask appropriate questions in conditions of risk. In action learning, examiners know the approved answers, so it does not allow workers for ambiguous responses.

Action learning is an educational process through which a person can improve his or her performance by studying his or her own actions. Put simply, it is about solving problems and getting things done.

According to peddler (1991), action learning is a vehicle for learning in an organization. This approach helps the people in an organization to develop their thinking and problem solving skills. Action learning is based on the principle that no learning will take place without serious and preplanned action and no serious and preplanned action will take place without learning. Action learning has three main components:

1. People who accept responsibility for taking action on a particular issue;
2. Problem or the task that people set themselves; and
3. A set of six colleagues who support and challenge each other to make progress on problem.

2.3.2.6 Problem-Based Instructional Strategy

In problem-based instructional strategies, the focus of learning is the problem. These problems are often related to real life situations and are ill structured. Inquiry model is used by problem-based instructional strategy instead of production model. In problem-based instructional strategy, first problem is presented to the students. Then they identify any previously gained knowledge or information if they have. The members of the groups plan to gather information. Individual research is conducted by the students and then they summarize and share their findings and newly gained knowledge with the other members of the groups. Finally, they present their conclusions. A proper time of evaluation is available but unlike project-based learning, the driving force in problem-based instructional strategy is the problem. (Esch, 2000)

2.3.3 DEFINITION OF PROBLEM

According to Uden, L. & Beaumont, C. (2006), a problem usually refers to a situation where there is a goal but it is not obvious how to reach that goal or several goals from which you need to select one to address. A person is facing problem when he does not know where he is and where he wanted to be. He can reach his desired destination by thinking over various possible solution paths to that problem. It can be a fun and exciting to find solutions to that problem based on related literature and content available. A problem is an opportunity for improvement. A problem is an opportunity knocking, the stroke of luck, a real break or a chance to getting of the grooving of everyday life and makes the life situation better. A person, who has awareness about the possibilities for improvement, brings a problem for him to solve. This is why the majority of the people who have creative mind are problem seekers rather than problem avoiders.

Because the problem is the central element of this instructional strategy, so the development of a problem is the main component of problem-based instructional strategy. A well-written problem will engage, motivate, and challenge students.

2.3.4 CHARACTERISTICS OF PROBLEM

A quality problem should have an apparent presentation that is regarded by an exterior audience. As most of the problems are completed and presented during the class time, it fosters the development of teamwork skill among the students. According to Tchudi and Lafer (1996), good problems have the following characteristics:

1. Puzzle the students to incite curiosity and motivate them towards learning.
2. Incite student's thinking on new things in new ways and puts them in the role of an investigator.
3. Assist the students to find out what they have to do.
4. Make sure that students arrive at further than what they already know and drives them to a solid knowledge base.
5. Generate a need and desire for information and skill.
6. Guide to understand the relationship of the process to the problem which make the process more sensible.
7. Guide to interdisciplinary query.
8. Build powerful communities of learners.
9. Guide to teamwork and collaboration in the strongest way that is based on determination and desire to do well.
10. Drives students to the higher levels of Bloom's Taxonomy.

2.3.5 OBJECTIVES OF PROBLEM-BASED INSTRUCTIONAL STRATEGY

Those who advocate problem-based instructional strategy, argue that it provides an effective environment to access knowledge and information across wide range of disciplines. Amabile (1996) stated that problem-based instructional strategy provides facilities for:

1. Encouragement in establishing ideas;
2. Not relying on training;
3. No fear of failure;
4. Provision of time and resources;
5. Development of expertise;
6. Talk focused positive feedback;
7. Encouraging a spirit of experimentation;
8. Provision of opportunities for group interaction;
9. Allowing free choice in task engagement;
10. Making a safe place for risk taking.

Barrows (1992) stated the following problem-based instructional objectives:

1. The development of students thinking or reasoning skills.
2. To help students become independent, self-directed learners.

Uden and Dix (2004) stated that the purpose of problem-based instructional strategy is to produce students who will:

1. Engage a challenge with initiative and enthusiasm;
2. Be able to reason accurately, effectively, and creatively from an integrated, usable, and flexible knowledge base;

3. Be able to address their own perceived inadequacies in knowledge and skills;
4. Collaborate effectively as a team member; and
5. Monitor and assess their own learning to achieve the desired outcomes.

2.3.6 LEVELS OF PROBLEM IN PROBLEM-BASED INSTRUCTIONAL STRATEGY

A good problem in problem-based instructional strategy reaches a higher cognitive level than a typical problem given at the end of the chapter. Sometimes a whole course is developed around a well-written problem situation. Duch (2001) categorizes problems by three levels.

A level 1 problem is a problem given at the end of the chapter. This type of problem checks only the low level of cognitive domain (knowledge or comprehension) of the student. The problem related to this level is limited to the topic in which all the information is given that is required for the solution of the problem.

A level 2 problem includes a storytelling feature and is given at the end of the chapter. The storytelling facet motivates the students for searching the solution of the problem. This level of problem involves the students to find solution of the problem through making some decisions and placing the questions of higher level of cognitive domain (comprehension or application). All the information required for the solution of level 2 problems is given in the chapter or the problem itself.

A level 3 problem have need of the highest level of cognitive domain (analysis, synthesis, or evaluation). This type of problem is related to the real world, drawing the student into the problem. The information required for the solution of this level of problem is not given in the problem nor in the chapter or even in the textbook. Students discover new information and knowledge through doing some research. This new information and knowledge help the students to make judgments and decisions related to the solution of the problem. In this level of problem, students often find out more than one acceptable solution to the problem during their search for the solution.

2.3.7 MODEL OF CURRICULUM SHIFT TOWARDS PROBLEM-BASED INSTRUCTIONAL STRATEGY

According to Severiens, S. & Schmidt (2009), problem-based instructional strategy is interdisciplinary in nature as it brings knowledge from various academic fields together. In past, the information and knowledge was transmitted from one generation to another generation through the words of mouth. Ultimately printing press and textbooks made the knowledge more accessible. Due to technological advancement in 21st century, information gathering and broadcast have seen rapid boost. Now, the students find knowledge and information in abundance and changing so speedy that the majority of them learn only a small portion of that knowledge.

In lecture-based instructional strategy, the teacher is expected to deliver content to the students through lecture. The role of the student in this strategy is to memorize a large amount of facts and information. Often facts or information may not be relevant to real world practices. This strategy is not proved useful in actual practices because the students

remained passive most of the time. The memorized facts or information may help the students to pass the examination but they fail to apply it to their daily work practices. The teacher is the expert and dispenser of knowledge and information and his job is to transmit the information to the students. (Uden, L. & Beaumont, C., 2006)

Today's there is rapid explosion of information and knowledge. It is very difficult for the students to learn a large amount of instructional material which is conceptually complex. Students face ill-structured problems in real life. Therefore, information needs to be discovered for the solution of problems emerged. The teachers have to develop necessary competencies and skills in their students so that they may keep pace with the rapid advancement and acquire the necessary knowledge and information on demand.

Currently, there is little being done to develop the necessary competencies and skills that students demand to become problem solver. As teachers, we are challenged to teach our students to learn to think and solve problems. This calls for reforms in our educational system because lecture-based instructional strategy is not preparing the students to perform decision making and problem solving tasks. It is therefore important for the researchers to examine and redefine the academic learning approach.

This increased the pressure on educational establishments to reform the way of teaching students in the subject of medical, law, business studies and education. A dramatic shift from lecture-based instructional strategy to problem-based instructional strategy is viewed in which transmission of knowledge by teachers to the reception of knowledge by the student is considered.

Problem-based instructional strategy offers a teaching tool through which students should be able to learn, remember and continue to learn when they leave the institution.

Problem-based instructional strategy uses complex, messy and open-ended problems as a starting point for learning to meet educational outcomes. This is different from the lecture-based instructional strategy where problem is used as an activity after teacher presents the content. In PBIS, the teacher presents an authentic, well-structured problem to the students before giving them any instruction.

The model of curriculum shift towards problem-based instructional strategy given by Tan, O. S. (2009) shows that problem-based instructional strategy involves shifting in three main points a)- content coverage to problem engagement; b)- role of lecturing to role of coaching; and c)- student as passive learner to that of active problem solvers.

The graphical representation of the model can be shown as follows:

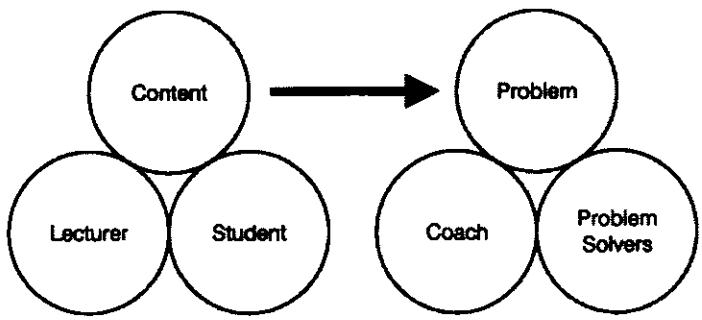

Figure 1: A Model of Curriculum Shift

In problem-based instructional strategy, the shifting is towards the use of real-world problem instead of acquiring information from the teacher. The students actively worked on problems to achieve desired learning outcomes. It is argued that students really learn best by using the real life problems rather than the subject matter as the center of attention. Students become active problem solvers rather than passive learners. Teachers take the role of coaches rather than knowledge transmitter.

Problem-based instructional strategy is one of the constructivist instructional strategies that have revealed much assurance in its application to disciplines where students have to deal with complicated problems in confusing situation. This instructional strategy structures the curricula on problems rather than on content of a course. Boud and Felleti (2007) also stated that problem-based instructional strategy is the structuring of curriculum in which students are confronted with problems for practice, which provides an inducement for learning.

Problem-based instructional strategy prepares the students to meet the challenges arising from the problem by employing constructivist's view of learning. According to the principles from a constructivist's view of learning, students:

1. Acquire necessary and usable knowledge and skill.
2. Develop problem-solving and reasoning skill.
3. Develop lifelong learning and upgrade their knowledge in order to remain up to date.

The efficacy of problem-based instructional strategy depends on the characteristics of the students and classroom environment as well as the problem presented to the students. PBIS as a philosophy aims to design and deliver a total learning environment that empowers the student and is holistic in nature. The supporters of PBIS believe that the students develop their own method for constructing their own procedure; they are actually integrating their abstract knowledge with their procedural skill.

2.3.8 LEARNING PROCESS IN PROBLEM-BASED INSTRUCTIONAL STRATEGY

The instructional techniques used in the implementation of problem-based curriculum are different from that of lecture-based curriculum. The learning process given by Butler, S. (1999) and agreed by many proponents of problem-based instructional strategy is as follows:

1. Problem is searched by students in groups (five to six students) without any prior knowledge and experience. Each group member discusses the problem with the facilitator when they started finding the solution of the problem.
2. The facilitator provides partial information to groups related to the problem and then they are stimulated with the task to recognize various aspects of the problem by asking questions to the facilitator to bring about information and knowledge related to the problem.
3. Facilitator helped the students in the development and improvement of hypothesis related to the solution of the problem. The major role of the facilitator is the development of hypothesis-driven reasoning skills in students.
4. In a group, relevant "learning issues" about the problem are established by the students that help them in finding an appropriate and acceptable solution to the problem.
5. Each member of the group is given task to research each of the different "learning issues" identified by groups.
6. Information related to assigned "learning issues" is gathered by the members of groups through using different resources and engaging in self-directed learning.

7. After researching the related learning issues, the members of the group state their findings to each other. Once the students stated their findings to the groups, they again established and re-examined the problem with the help of newly obtained knowledge and skill for reaching at an appropriate solution to the problem.
8. Finally, the students think about what they have learned through the process of finding solution to the problem after presenting their solution to the class and also to the facilitator.

The learning process in PBIS can be shown as the following:

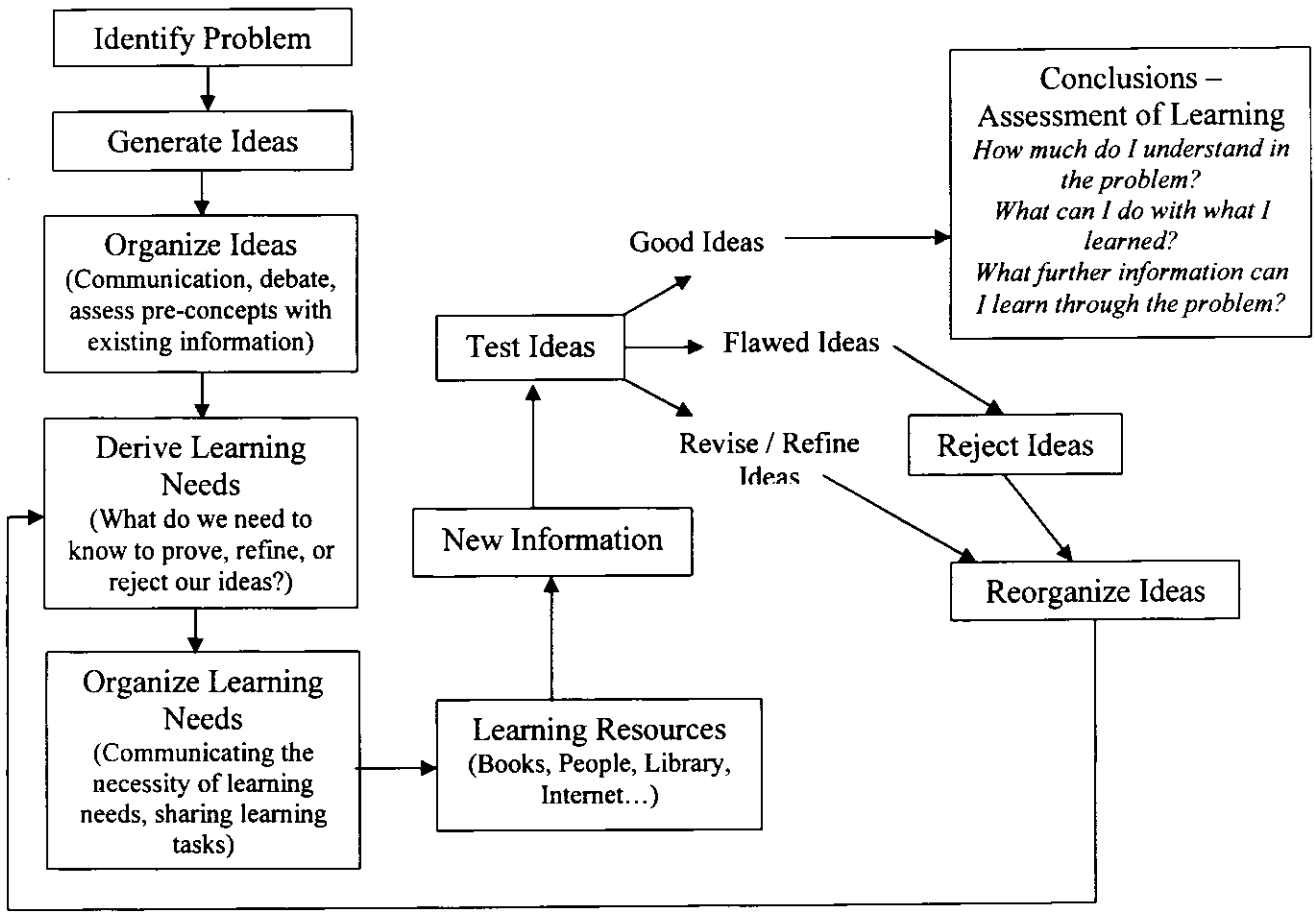

Figure 2: Learning Process in Problem-based Instructional Strategy

Source: Original appeared in Wang, Thompson , Shuler, & Harvey (1999). Problem-based Leaning for Science Teacher's Professional Development. Paper Presented at the 1999 AETS Annual Conference, Austin, Texas

In problem-based instructional strategy, problem drives the learning. The students are presented with a problem and then they learn by solving that problem. The problem presented to students is ill-structured so they acquire new knowledge and information to reach at the solution of the problem.

2.3.9 STAGES IN PROBLEM BASED INSTRUCTIONAL STRATEGY

Stepien (1993), Duch (1995) and Edens (2000) stated three basic stages of problem based instructional strategy.

Stage 1: Confronting and defining problem

The teacher gives a problem to the students for the purpose of learning through finding solution to the problem. The problem is generally prepared in case study format and is considered to be well-structured and related to the problems of real life situation. The students find solution to the problem by organizing related ideas and knowledge of the problem through working together in groups. The students ask additional questions, identify the key areas of the problem, collect more information and finally redefine the problem to reach the solution more accurately.

Stage 2: Accessing and investigation

Once the problem has been clearly defined by the students, they now plan to solve the problem. The students execute investigating the problem after assigning the work among them. This is the stage at which teachers and students work together to discuss the required resources needed to solve the problem.

Stage 3: Synthesis and performance

This is the stage where the students produce the solution of that problem. Here students may create presentation, which targeted on important questions. Students are motivated to think about their learning and are asked to share their ideas and information to the members of other groups.

In PBIS, the teacher tries to facilitate the students learning through critical thinking and to make them able to find out related information about the problem.

Barrows and Kelson (1993) stated that in problem-based instructional strategy, students mainly learn through self-directed learning, teamwork and finding solution to the problem. In this respect, Greenwald (2000) described these stages as steps and gave the following 10 steps model of problem based instructional strategy:

1. **Confront with a well-defined problem.** It is the backbone of problem-based instructional strategy. Greenwald (2000) described that a well-defined problem is unclear in nature and it raises questions about the known and unknown part of the problem.
2. **Asking questions.** In this step, open-ended questions can be asked by the teachers to the students. Interesting interpretations can be considered in a discussion session to find out the important elements of the problem.
3. **Follow different problem-finding strategies** for categorization and elucidating problems offered by the teacher.
4. **Give precedence to the problem and plan problem-finding activities.** In this step, students reorganize the problems that are identified in the previous step.

5. **Examine the problem.** To help the students to plan their investigations, inquiry based question can be used.
6. **Analyze results** with the help of inquiry guided questions.
7. **Restate learning.** It is an eminent characteristic of PBIS where the students present their learning material to their class fellows.
8. **Generate solutions to the problems and give recommendations.** By revisiting the analysis of results and restate learning, students develop solutions to the problem, generate new ideas and recommendations.
9. **Share the results.** Students share their learning that they have gained through problem solving process to the teacher and other peers.
10. **Conduct self-evaluation.** Authentic evaluation strategies can be used for the students who give group findings, problem solving, knowledge acquisitions, and self-directed learning skills.

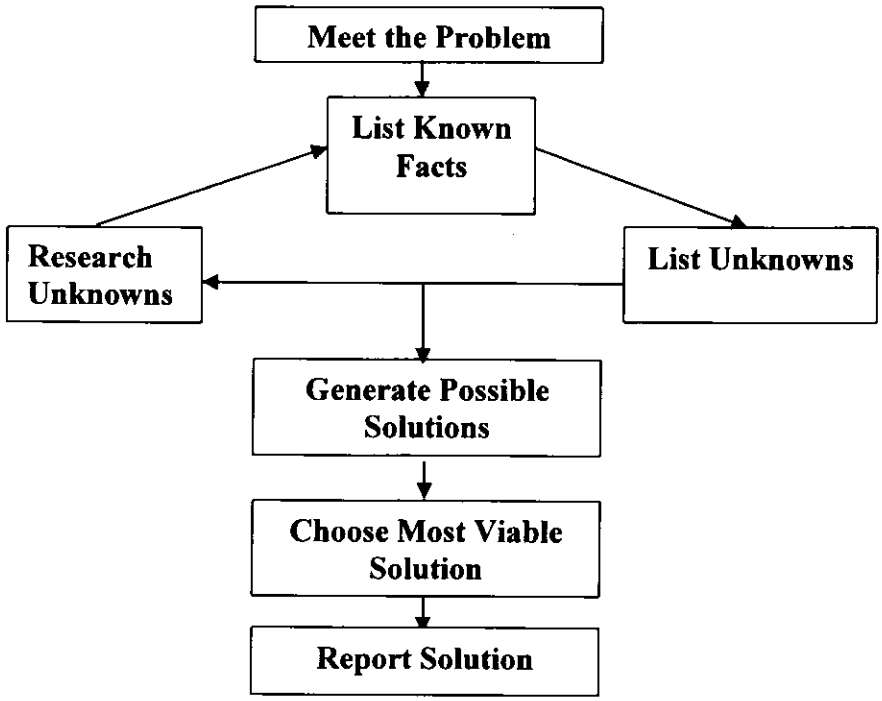

Figure 3: Stages in Problem-based Instructional Strategy

Stephen, Gallagher, and Workman (1993) stated the following summary while outlining the steps of problem-based instructional strategy.

Problem-based instructional strategy is training for real life problem solving. In this instructional strategy, students find well-defined problem or situation from the information and knowledge presented to them. When the students locate the problem, they define the related learning issues, generate hypothesis, scan and search for the data, improve hypothesis with the help of data collected, control and direct experiential experiments, develop solution that best suit the conditions of the problem and finally evaluate the solutions to find out the expected reasons that will help in the improvement of the conditions. The students integrate the subject knowledge and study issues at a deep level rather than surface level.

2.3.10 CHARACTERISTICS OF PROBLEM-BASED INSTRUCTIONAL STRATEGY

Gallagher (1997) stated that the prime goal of problem-based instructional strategy is to develop learning capability of the students. He revealed that research and investigation can and should be included as a tool in problem-based instructional strategy for problem solving. He highlighted that students in problem-based instructional strategy plan their own research and investigation by asking a series of questions. The questions proposed by Gallagher are:

1. What do I know?
2. What do I need to know?
3. What do I need to learn?

4. How do I quantify or illustrate the results?

According to him, there are three features that set the parameters of PBIS instructional strategy:

1. Problem initiates learning
2. Limited use of well-structured problems
3. Instructor as a meta-cognitive coach

There are many such characteristics of PBIS, which clearly distinguish it from lecture-based instructional strategy. PBIS involves small groups of students which are facilitated by the teacher whereas lecture-based instructional strategy is often conducted in a teacher centered mode.

Margetson (1991) indentified three important characteristics of problem-based instructional strategy. These are:

1. Problem-based instructional strategy encourages active, reflective and open minded learning.
2. In problem-based instructional strategy, teachers and students worked together and share their information and knowledge in the educational process. This strategy pays high value to both the teachers and students due to their knowledge, interests, feelings and understanding of the concepts.
3. Problem-based instructional strategy reflects the nature of knowledge i.e, knowledge is complex and changes as a result of responses by communities of persons to problems they perceive in their worlds.

Kay, J. (1997) suggested following characteristics of learning in problem-based instructional strategy:

1. **Learning in Situation:** In order to solve the problem, skills are acquired and this is very much like the real world situation in which skills are usually required.
2. **Problem Motivates Learning:** In contrast to the lecture-based instructional strategy in which students are informed what to learn and then they are supposed to solve the problems in order to test their memory of information, PBIS put forward the students with authentic problems that motivate their learning.
3. **Integrated Learning:** As the learning in PBIS is motivated by the problem, it will therefore have flexible curriculum that results in integrated learning.
4. **Ownership of Problem:** In PBIS, students are allowed to assign their own meanings to the problem to find out the solutions. So the students are given the ownership of the problem and the role of the teacher is only to facilitate and guide the student.
5. **Self-Directed Learning:** In problem-based instructional strategy, students are by and large responsible for their own learning and they pass through the material on their own motivation. The problems only provide vital support to them.
6. **Learning about Learning:** Problem-based instructional strategy also concentrates on the learning process as well as the learning through problem solving. In this way, the students are asked to reflect on the process of learning about problem solving.

7. **Collaborative Work:** Problem based instructional strategy grasps the well-known benefit of group based work and encourages the students to learn in a stimulating environment.
8. **Well-defined Problem:** The problems developed in PBIS are authentic in nature because they are not artificially controlled. These problems necessarily have not a single correct answer so the problem is left open for illustration and is anticipated to be redefined in accordance with the growing understanding of the problem.
9. **Recognition of the Prior Learning:** Students enter a course having a range of skills, experiences, knowledge and understanding. So problem-based instructional strategy also make the student's familiar with their prior learning.

Boud (1985) characterizes the features of problem-based instructional strategy as following:

1. Learning process started with the presentation of a problem.
2. The problems presented in an educational setting are realistic in nature.
3. Learning processes are organized to find out the solutions of the problem.
4. Accentuate the responsibility on the students and learning initiative.
5. Better adjustment of student's knowledge and information at the start of learning.
6. More capacity of integrating multidisciplinary subjects, and
7. Students and teachers have more cooperative relationship in learning process.

Bridges (1992) stated five characteristics of problem-based instructional strategy as follows:

1. Learning starts with a problem.
2. The students face the problem.

3. The knowledge and skill acquired by the students is organized around the problem.
4. Students independently and in a groups are supposed to face the responsibility for their own learning, and
5. Lecture has very little to do. Most of the learning occurs in a small group rather than lectures.

According to Duch (1995), problem-based instructional strategy is an instructional strategy that uses problems relevant to real world situation. Students acquire essential knowledge and information with the help of these real world problems and develop their problem solving and critical thinking skills. It is an instructional strategy that places learning in intricate and significant problems that are framed in genuine situations. Problem-based instructional strategy also enhances student's ability through reaching at the solution of authentic real world problem. It also improves the ability of the students to:

1. Define the problem clearly.
2. Give new information through the development of alternative hypotheses.
3. Evaluate and utilize data from a number of different resources.
4. State the solutions clearly that fit the problem.
5. Develop well-organized and effective self-directed learning skills, and
6. Develop group skills that include giving and receiving performance feedback.

According to different educationists (Tan, 2009; Walker, 2003; Oliver, R. Omari, A. & Stoney, C. 1999; Lennox, 1998; Coles, 1990), problem-based instructional strategy has gained in popularity in various disciplines due to its numerous developments.

First of all, there is a need to bridge the gap between theory and real world practice. This gap was apparently removed in medical education through the engagement of students in problem solving process. This strategy has its own origin in medical field, so it is considered as an effective way of training medical students. The students in medical education learn more through problem-based instructional strategy than the lecture-based instructional strategy with respect to problem solving, self evaluation, data gathering and other learning skills.

Secondly, improved information and knowledge is available which is easy to understand. The teachers have appreciated the students to use problems for the improvement of their learning and thinking skills. However, students cannot establish the problem due to lack of their information and knowledge. That is why, students are often engaged in a problem after dissemination of information and knowledge and are confined to the information and knowledge already provided to them.

Thirdly, in problem-based instructional strategy, real world competencies like problem solving, independent learning, critical thinking, collaborative learning and decision making are more stressed.

Fourthly, the development in teaching methodologies and social sciences also supported the use of problem-based instructional strategy in these areas.

As we know that some students are 'novice' learners while the others are 'expert' learners. Thus, these students can only become better learners when they are provided with the opportunities for getting hold of different strategies involving problem solving skills and exploration of real world situations. Thus PBIS works as a replacement for traditional lecture-based instructional strategy in which the individuals are engaged and from this pedagogical perspective, educationists believe that PBIS is based on the constructivist's theory of learning. So, in problem-based instructional strategy, students learn with the interaction of presentation of problem and learning environment where knowledge evolves through collaborative processes of social negotiation and evaluation of the capabilities of one's point of view.

2.3.11 ADVANTAGES OF PROBLEM-BASED INSTRUCTIONAL STRATEGY

Many teachers in schools believed that the use of problem-based instructional strategy is only the solution to the problem faced by them during the teaching learning process. This instructional strategy enables the teachers to add different strategies including, problem solving, collaborative learning, critical thinking and independent study to improve their traditional method of teaching.

The researchers have generally established a point of view that problem-based instructional strategy has many advantages. Some of the advantages given by different proponents of problem-based instructional strategy are:

1. The problem-based instructional environment is more stimulating and human (Albanese & Mitchell, 1993; Norman & Schmidt, 1992)

2. Problem-based instructional strategy promotes interdepartmental collaboration between basic and clinical scientists. (Norman & Schmidt, 1992)

3. Problem-based instructional strategy helps the students and teachers to enjoy more learning and teaching. (Albanese & Mitchell, 1993; Vernon & Blake, 1993; Norman & Schmidt, 1992)

4. Problem-based instructional strategy promotes interaction between students and faculty. (Finucane, Johnson & Prideaux, 1998)

5. Problem-based instructional strategy promotes deeper rather than superficial learning. (Eagle, 1992; Newble & Clarke, 1986)

6. Problem-based instructional strategy helps in enhancing and retention of self-directed learning skills. (Norman & Schmidt, 1992; Barrows & Tamblyn, 1980; Dolmans & Schmidt, 1996; Blumberg & Michael, 1992)

7. Problem-based instructional strategy fosters self-directed learning skills. (Barrows & Tamblyn, 1980; Norman & Schmidt, 1992; Blumberg & Michael, 1992; Dolmans & Schmidt, 1996)

8. Problem-based instructional strategy promotes interaction between different disciplines. (Finucane et al., 1998)

9. Problem-based instructional strategy promotes collaboration between students. (Banta, Black, & Kline, 2000)

10. Problem-based instructional strategy enables reflection-in-action. (Schon, 1983)

11. Problem-based instructional strategy matches current efforts to involve students more actively in their education and it improves their learning. (Norman & Schmidt, 1992)

12. Problem-based instructional strategy enables students to spend more time on self-directed learning activities, using more information resources. (Vernon & Blake, 1993)

13. Problem-based instructional strategy enables staff to have more contact with students. (Albanese & Mitchell, 1993)

Gallagher et al. (1997) viewed that problems presented in PBIS are the copy of real life situations. Because PBIS is interdisciplinary in nature, it permits the students to observe how diverse subjects act together when solving the problem. In this instructional strategy, the teachers authorize the students to become self-directed and independent learners.

Smith (1995) characterizes the advantages of PBIS and stated that problem-based instructional strategy:

1. Improves critical thinking, knowledge, skill and cognitive abilities in students.
2. Support independent study because the students trained in problem-based instructional strategy use libraries and other information resources more regularly for the solution of their problem.
3. Helps in developing life long study skills, particularly in early years of study.
4. Improves the holistic approach of the students to the subject.

5. Increases student's interest and gratification about the subject and improves professional development.
6. Helps in integration of new information, and
7. Works well when a student works as a member of team.

Previous researches showed that problem-based instructional strategy helped the students to improve the ability to trigger advance organizers more effectively, use of increased explanation of relevant information for encouraging them to do mental process and development of better understanding, recall and learning with the help of real world situations. In PBIS settings, students take on the role of scientists, doctors, engineers, historians, programmers, mechanics or any others who have a chance to face problem. That is why the students in PBIS work with the problems in such a way that it fosters their reasoning and knowledge application skills.

2.3.12 THE CHALLENGE OF PROBLEM-BASED INSTRUCTIONAL STRATEGY

The modification of traditional lecture-based instructional strategy and implementation of new one is often a difficult task for the teachers to incorporate and the same is with problem-based instructional strategy.

Jones (1996) pointed out that the development of appropriate questions is the most decisive aspect of problem-based instructional strategy. He further emphasized the importance of appropriate assessment of the performance of students. According to him, teachers in problem-based instructional strategy require more appropriate assessment methods and techniques like written exams, practical exams, self assessment, structuring

of concept maps and oral presentations as compared to lecture-based instructional strategy where the academic achievement of students is only assessed with the use of standardized tests.

Ngeow and Kong (2001) stated that students involved in problem-based instructional strategy learn mostly through independent study but they find difficulty in conversion towards self-directed learning for enhancement of their own learning capability. Group based learning is another aspect of PBIS and students must learn to perform effectually and efficiently in groups.

Another challenge to problem-based instructional strategy is the cost and resistance to change among the teachers and this can be tackled through the professional development of teachers in PBIS environment.

Albion and Gibson (2000) noticed another factor in teacher education that prevents the change in teaching learning process. According to them, programs depend deeply on traditional lecture format and rote learning. So it is hard to believe that the teachers adopt learning methodologies that they have not practiced personally. Because many administrators, teachers and curriculum developers have deficient experience in interdisciplinary education, barriers to extensive change turn out to be insuperable.

Dearth of well-equipped material for classroom is another barrier to problem-based instructional strategy. The textbooks and curriculum present today do not include the variety of sample problems that require supporting methodology on a large scale.

Not only the well-structured problems are inaccessible for the curricula of many of the public schools, the assessment method used in these schools is also product driven

and information based. The performance of the teachers and students is examined through standardized test that does not check critical thinking skill. Many teachers believe that they cannot give the time necessary for PBIS due to the administrative pressure to improve test scores.

2.3.13 USING PBIS AS AN INNOVATION TOOL

Problem-based instructional strategy is an educational tool that improves learning of the students, sharpens student's problem solving skills and improves student's independent learning skills. According to Bridges (1992), the application of problem in problem-based instructional strategy is often subjected to:

1. Selection of approach according to the decision makers' objectives.
2. Use of available resources and help of experts with their limitations.
3. Prospect and possibility of program, subject or course change.
4. The limitations of using problem-based instructional strategy in each program where teacher desired to implement PBIS as an instructional strategy.

These points do not signify that by using problem-based instructional strategy, we cannot achieve improvement where possible. The main thing to remember is that we should not confuse poor design of problem-based instructional strategy with that of well-developed instructional strategies that are used by the teachers to meet the wide-ranging variety of needs, objectives and limitations.

The teachers in conventional educational environment decide to use PBIS as a delivery tool for innovative alternatives to teacher-centered approach. These teachers

observe the weaknesses in the delivery method that put emphasis on teaching rather than learning.

Problem-based instructional strategy empowers students to acquire many important skills that are essential in life. It encourages taking an inquisitive look at all concepts, issues and problems within the given problem. Problem-based instructional strategy enables students to develop the skills of retrieval of literature, critical appraisal of information and ability to seek information from other members of the groups and experts. Students are more involved in problem-based instructional strategy and they take full responsibility for their own learning.

Students face ill-structured and complex problems in real life situations. Information is gathered relevant to problem. In the absence complete information about the problem, decision is made and action is taken. This is particularly true for today's science students. These students must have the ability to identify formative evaluation and solve problems.

According to Barrows (1998), in professional practice, the information required to make valid decisions and understanding of problem is presented by very few problems. Students solve the problem with the help of reflected facts, concepts, stored knowledge in the memory and prior experiences relevant to the problem. Students recall some of the information automatically having familiar factors of the problem encountered. To be able to recall the rest requires deliberations, thoughts, reviews and reflection. Students obtained the required information and knowledge by studying problem, making observations, testing, asking questions and probing.

In addition to internal information, the students need external information including records, books, on-line journals, technical reports and opinion of various experts for solving new, unusual, unexpected or complex problem. Deliberation and reflection are again needed for students to decide what external information resource is needed and how it might be found.

New information is obtained by probing and examining the problem through inquiry. This may change the perceived nature of the problem and new twists and ramifications may occur to the problem. This again requires reflection and deliberation. At some point, the student is expected to make decisions in problem solving process on the basis of intuition.

Barrows (1998) defines meta-cognition as the function in thinking, reflecting or making purposeful effort on problem solving; reviewing what is known and remembered about the problem faced. It is the process of hypothesis development, questioning, making decisions about observations, searching for new sources of information and then questioning the new information obtained from inquiry and finally reviewing on what has been learned and what needs to be done and so on. In other words meta-cognitive skills are "thinking about thinking".

In today's education it is increasingly recognized that students should become effective thinkers. The students must be prepared with the skills like thinking and lifelong learning so that they may function effectively in a rapidly changing and highly technical society. In this changing world, thinking and lifelong learning skills are necessary for the students to acquire and process new information and knowledge. (Robinson, 1987)

The teaching of thinking skills is very important to cope with the complexity and rapidly changing needs of technological advances. In order to develop thinking skills in students, an environment should be provided to them where thinking skills can be learned and then practiced in realistic situation. The teacher have to teach about thinking, teach for thinking and infuse thinking into content for developing thinking skills in students. Thinking must be modeled and facilitated throughout the teaching learning process of the students. Infusing thinking into students learning can be done by changing the way of teaching students.

According to Chubinski (1996), strategy for teaching thinking skill includes:

1. Identifying the Problem
2. Deciphering the Purpose
3. Uncovering the Assumptions
4. Recognizing and using different paradigms
5. Demonstrating different methods of reasoning
6. Examining data
7. Creating alternative solutions
8. Evaluating one's thinking to improve it.

In our modern society, ability to work collaborately is one of the necessary skills. Team working skill brings students from diverse background and tradition together where they can better understand one another and promote social interaction between different cultural groups.

One of the most important skills used by the teachers to facilitate learning in problem-based instructional strategy is questioning. It is important for teachers to know what questions to ask and when to ask. The main objective of asking question is to help students to make their knowledge explicit for solving the problem. The teacher should be sensitive to the questioning approach of the students. The teacher should not bombard too many questions to the students. This can frustrate the students and thus make them uncertain about their learning.

2.3.14 COGNITIVE EFFECTS OF PBIS

According to Schmidt (1997), the acquisition of knowledge in PBIS is thought to work by means of following cognitive effects:

1. Preliminary analysis of the problem and initiation of previous knowledge through small group discussion.
2. Explanation of previous knowledge and effective processing of new information and knowledge.
3. Reorganization and restructuring of knowledge, construction of verbal network.
4. Construction of social knowledge.
5. Learning in situation, and
6. Encouragement of inquisitiveness associated to the presentation of a relevant problem.

Some theories advocate that learning happens as students cooperatively involve with the concepts of meaningful problem solving. In this view, knowledge is perceived as

a tool for critical thinking and for empowering the students to involve themselves in meaningful activity.

2.3.15 STUDENTS UNDERSTANDING IN PBIS ENVIRONMENT

The environment in problem-based instructional strategy differs from lecture-based instructional strategy classroom environment where students are generally considered good and classes are well organized and the students obtain high scores on standardized tests. However, this traditional environment or lecture-based instructional strategy does not necessarily enable the learner to develop critical thinking skills.

Instead of developing deep understanding of knowledge and concepts, students in lecture-based instructional strategy tend to learn irrelevant and counterproductive concepts. As a result, this lecture-based instructional strategy pays attention only to obtaining good scores on performance tests. In comparison to traditional classroom environment, problem based learning environment provides learner with opportunities to ripen their capabilities to acclimatize and modify methods to fit new situations.

According to Norman & Schmidt (2000), PBIS program improved the motivation of the students. Vernon & Blake (1993) found that the students demonstrated more satisfaction to their educational achievements when they are practiced with PBIS. On the other hand, Williams et al. (1999) investigated the learning science concepts of 7^{th} grade students and found that the learning attitude of the students was not affected by the introduction of problem-based learning.

2.3.16 TEACHERS ROLE IN THE PBIS ENVIRONMENT

Teacher's instructional abilities and roles are less defined in problem-based instructional strategy environment than the lecture-based teacher-centered environment. In PBIS environment, students employ themselves in organizing new obtained information and knowledge and then they use their obtained knowledge in actual practical situations. The teacher's in PBIS settings should have profound experience and understanding of the concepts being taught to the students so that they can direct the students to apply the obtained information and knowledge in different problematic situations. In PBIS environment, the teachers with little conceptual knowledge may lead the students towards failure. Without deep understanding of the concepts, teacher would neither select suitable tasks for the development of the student problem solving strategies nor plan suitable problem-based activities for classroom. (Camp, M. G. & Anderson, A. S., 1996)

According to Bridges and Hallinger (1996), the main role of teacher in problem-based instructional strategy is to help students to learn. The teacher in PBIS works as a facilitator or coach rather than dispenser of information and knowledge. So, the teacher provides support to the students in teaching/learning process rather than teaching them aloud.

In Pakistan, science concepts have been taught at secondary school level and college level through traditional lecture-based instructional strategy for many years. Although in some schools/colleges, problem based instructional strategy has been used recently but the teachers are still confused about the implementation of this instructional strategy.

According to Clark (1997), only the teachers who noticed the practices linked with problem-based instructional strategy can be benefitted from their professional development. Science teachers more eagerly learn to supervise the problem-based learning environment when they understand the changed role of the teacher and think preparing the problem-based learning environment as a possibility to assist professional growth.

The students have to take the responsibility and search for the resources to solve the problem as the teacher provides only the assistance that encourages their advancement. The students develop skill and abilities in PBIS process that lead to the solution of the problem. Therefore, in PBIS environment, the problem should be developed in such a way that the learners accept them as their own problem.

In problem-based instructional strategy, the role of teacher is changed from teaching to counseling of the students. In this instructional strategy, a problem is presented to the students and the teacher remains in touch with the students to provide them facilitation, direction and assistance to their thinking by asking questions for reaching at the solution of the problem.

The teacher must take on the new roles to implement problem-based instructional strategy effectively. In lecture-based instructional strategy, the teacher has full control on teaching/learning process through communicating information and knowledge to the students but in problem based instructional strategy, teacher picks out a problem, handover it to the students and then provides facilitation for searching out the solution of the problem through inquiry. In this instructional strategy, the whole process of problem

solving is controlled by the students and the teacher only works as a coach or facilitator to the students.

This change is unsustainable for many teachers and such a case has happened with Boud and Felletti (1991) when a teacher helping them in research said that he could not manage this. He further said that he wanted to be in full control while PBIS did not allow this. These teachers struggle without the full control and authority that is the distinctive feature of lecture-based classes.

2.3.17 KEY DIFFERENCES BETWEEN LBIS AND PBIS

Problem-based instructional strategy is an instructional strategy that helps students in learning the skills of problem solving and thinking which is not often acquired in lecture-based instructional strategy. In problem-based instructional strategy the content is presented in the form of complex real world problems relevant to daily life situations. In problem-based instructional strategy, problem comes first whereas in lecture-based instructional strategy concepts are presented before the end of chapter problems.

According to White (1996), students in lecture-based instructional strategy solve the problem by applying information provided by the teacher. The students in this strategy showed that they have understood the theory and its application but in problem-based instructional strategy, students forms small groups and work together to identify their needs. Students are required to go beyond their textbooks in problem-based instructional strategy to pursue in knowledge and information between group meetings.

In problem-based instructional strategy, students have to take control of their own learning. Teacher's role in problem-based instructional strategy is very different from

lecture-based instructional strategy. Instead of teacher being a dispenser of knowledge in lecture-based instructional strategy he acts as a facilitator or coach in problem-based instructional strategy. The students have greater control of their learning and are expected to be independent learner rather than dependent on their teachers.

Jones, Rasmussen & Moffitt (1997) concluded some key differences between lecture-based instructional strategy (LBIS) and problem-based instructional strategy (PBIS). They described that the key differences are mainly related to learning goals and activities, teacher's role, student's role as a learner, assessment, learning meta-outcomes and nature of learning tasks. These key differences are shown in a table given as under:

Table 1: Key differences between Lecture-based Instructional Strategy (LBIS) and Problem-based Instructional Strategy (PBIS)

Key differences	LBIS	PBIS
1. Learning goal and activities	Teacher directed	Student's responsibility
2. Teacher's role	Expert and dispenser of knowledge	Coach, facilitator
3. Student's role as a learner	Passive or reactive	Active
4. Assessment	Knowledge-centered assessment	Project-based assessment
5. Learning meta-outcomes / goal targeted	Learning of fact and value	Critical thinking, higher level thinking, cognition
6. Nature of learning tasks	Close-ended, well-defined content, distanced from real world situation	Open-ended, connected to real world situation

Keeping in view the table, we find that problem-based instructional strategy is a student centered process that fosters the skills of the students for lifelong learning. Although the lecture-based instructional strategy is considered to be the most

predominant teaching tool, yet its effectiveness of facilitating students learning is questionable that led to the educational research and in response the methodologies like problem-based instructional strategy has arisen.

In summary, problem-based instructional strategy is an instructional strategy that enables the students to learn problem solving and acquire knowledge about the basic science. Students in problem-based instructional strategy meet in small group often two or three times per week. A problem is presented to them. In a series of steps, students discuss possible mechanism; develop hypothesis and strategies to test the hypothesis. Further information is then presented to students to refine the hypothesis and finally reaching a conclusion.

According to Meyers and Jones (1983), during the lecture about 40% of the time, the students are not attending to what is being said. In this strategy, students can retain only 70% of the subject matter in the first 10 minutes while in the last 10 minutes they can only retain 20% of the lecture. As the lecture proceeds, students continuously lose their interest and attention in the lecture and after 4 months, the students taught through lecture-based instructional strategy knew only 8% more than the students who had never taken that course.

2.4 RESEARCH ON PROBLEM-BASED INSTRUCTIONAL STRATEGY

In this part of literature review, some existing researches related to problem-based instructional strategy is given. The existing research review showed that there have been very few research studies conducted to-date on the effectiveness of problem-based instructional strategy in the world particularly Pakistan.

In this literature review, some findings on the application of problem-based instructional strategy and lecture-based instructional strategy in different research studies are reported and reviewed. Several research studies suggested that the process of acquisition of knowledge and skill is enhanced in problem-based instructional strategy while few other research studies showed that students decreases in their attainment of knowledge in basic science subjects when they are taught through problem-based instructional strategy.

Schmidt (1998) did a research at Maastricht University on medical students in which he found that the students taught with problem-based instructional strategy had a much higher level of proficiency in the professional skills than the students taught with a conventional curriculum.

Megendiller, Maxwell, and Bellisimo (2002), examined the possible difference between problem-based instructional strategy and traditional lecture-based instructional approach on development of macroeconomics knowledge in high school students. They found that problem-based instructional strategy is more helpful to students in learning basic macroeconomics concepts than the traditional lecture-based instructional approach.

Visser (2002) compared the effectiveness of problem-based instructional strategy and lecture-based instructional strategy and conducted a research study on student's problem solving attitudes. She found that there is statistically significant difference in learning and motivation between the students taught through both the instructional strategies. She further reported that the students in problem-based instructional strategy are less motivated towards learning but more confident towards problem solving.

Albanese, M., & Mitchell (1993) investigated the overall effects of problem-based instruction. The question guiding this meta-analysis was "What does literature tell us about outcomes and implementation issues related to problem-based instruction". They found that students in problem-based instructional strategy enjoy working together in groups and performed better on clinical examination and faculty evaluation. Further, learning was retained longer by PBIS students than conventional students. The evidence comes from the fact that students scores did not decline over time to the same degree as conventional students' scores.

Dochy, F., Segers, M., Vanden Bossche, P., Gijbel, D. (2003) examined the effects of problem-based instruction in terms of impact on knowledge and skill acquisition. They found that students showed better results for both knowledge and skills related outcomes when they are given treatment of problem-based instructional strategy. The results of the students for skills give a consistent positive picture. They also found that the students in problem-based instructional strategy gained a little more information and knowledge and retained more of the acquired information and knowledge for a longer period of time.

Albano (1996) did a research to find out the differences on level of knowledge acquisition through problem-based instructional strategy and lecture-based instructional strategy. He concluded that the problem-based instructional strategy have very much effect on the level of knowledge acquisition than the lecture-based instructional strategy.

Johnson, E., Herd, S., Andrewartha, K. (2002) in their study "Introducing problem-based learning into a traditional lecture course" assessed student satisfaction in a course that used a combined problem-based learning and lecture format. They reported

that student responses to a questionnaire in the first year of the study indicated that they were satisfied with the PBIS program most of the time. A more informal assessment of students' responses was conducted in subsequent years but yielded similar results.

According to Boud and Feletti (1997), problem-based instructional strategy is a power teaching methodology through which students are encouraged to learn by their own. They stated that in problem-based instructional strategy, the students motivate themselves actively towards the needs of their life for the solution of the problems.

Derectchin and Contant (1999) looked at the learning behavior of the medical students through the evaluation of traditional versus problem-based instructional strategy curricula. They concluded that the students having problem-based instructional strategy curricula performed slightly lower on self-directed learning and this was due to wide ranging changes in problem-based instructional strategy curricula over the years. Instead of this, they also stated that students had showed positive trend towards accepting problem-based instructional strategy as an instructional strategy for lifelong learning.

Warburton and Whitehouse (1998) studied the perception on integration of knowledge in 118 medical students. They found that although students in problem-based instructional strategy met their course objectives yet the problem-based instructional process did not meet the personal goals of the students. They further recommended that additional research studies should be considered to find out the differences in what students wants and what students needs to equip them with lifelong learning skills.

Vernon and Black (1993) reported that PBIS impacts the attitude of the students positively as compared to the other instructional strategies. They further said that in PBIS, students showed significantly higher levels of motivation and satisfaction.

Breton (1996) analyzed students in an accounting theory class in which he compared two classes of students to determine the difference in knowledge acquisition and aptitude for problem solving in lecture-based instructional strategy and problem-based instructional strategy. He found that the problem-based instructional strategy is more effective than lecture-based instructional strategy on acquisition of knowledge and problem solving. He further concluded that the students in problem-based instructional strategy showed greater command on long term acquired knowledge and lifelong learning than the students in lecture-based instructional strategy.

Dods (1997) studied the effectiveness of PBIS in elevating acquisition of knowledge. He selected 30 students from biochemistry course at the Illinois Mathematical and Science Academy. The content of this course was covered through problem-based instructional strategy, lecture-based instructional strategy and an amalgamation of both the PBIS and LBIS. Data were collected by using pre-test and post-test to examine the student's depth of understanding. It was found that although content was delivered easily through lecture-based instructional strategy but PBIS is more effective in promoting complete understanding of the key concepts of biochemistry content.

According to Norman and Schmidt (2000), problem-based instructional strategy enhances relocation of concepts to new problems, concept assimilation, inherent interest in learning, and learning skills.

Albanese and Mitchell (1993) discovered that problem-based instructional strategy is more helpful in edification of knowledge as compared to lecture-based instructional strategy.

Margetson (1994) believed that PBIS foster 'deep' learning, encouraging participative, cooperative, and critical engagements of the learners. In contrast, the lecture-based instructional strategy is characterized as 'didactic and directive' emphasizing on only recollection of knowledge.

Furthermore, majority of problem-based instructional strategy researches have been conducted on the students having age more than 25 years. No study has yet targeted the students aged between 15 to 20 years regarding achievement, retention and problem solving capabilities in conjunction with problem-based instructional strategy and lecture-based instructional strategy. The current study provided valuable data regarding secondary school students in relationship to the problem-based instructional strategy and lecture-based instructional strategy.

It is obvious from the previous discussion that problem-based instructional strategy offers many learning benefits to students compared to traditional methods. Students who are taught using problem-based instructional strategy have retained their learning better than non-problem-based instructional students. They also do as well in tests of content knowledge as students in traditional curricula.

CHAPTER 3

RESEARCH METHODOLOGY

The purpose of study was to observe the effectiveness of problem-based versus lecture-based instructional strategies in teaching the subject of "General Science" at secondary school level. The study was experimental in nature. So the experiment was conducted at two different places independently. The researcher selected four chapters from the textbook of "General Science" for class 9th approved by Federal Ministry of Education, (Curriculum Wing), Government of Pakistan. The four chapters were "Our Life and Chemistry" (Chapter 2), "Microorganism and Diseases" (Chapter 5), "Energy" (Chapter 7), and "Basic Electronics" (Chapter 9).

3.1 POPULATION OF THE STUDY

The target population for this study consisted of 6303 male students studying the subject of "General Science" in 53 Federal Government (FG) Boys High and Higher Secondary Schools in Islamabad district working under the administrative control of Federal Directorate of Education (FDE), Islamabad.

3.2 SAMPLE OF THE STUDY

The sample of this research study belonged to the rural area of Islamabad, so the researcher selected Federal Government Boys Higher Secondary School (FGBHSS), Rawat, Islamabad from Sihala area and Federal Government Boys High School (FGBHS), Sangjani, Islamabad from Ternol area and their 9th class students studying the

subject of "General Science" constituted the sample for this research study. The sample selection of those two areas and schools were taken through purposive sampling. The synoptic view of the sample taken for those two experiments is given in the following table:

Table 2: Sample size in FGBHSS, Rawat and FGBHS, Sangjani

Groups	FGBHSS, Rawat (N = 67)		FGBHS, Sangjani (N = 41)		Total
	Control Group	Experiment Group	Control Group	Experiment Group	
Total	**34**	**33**	**20**	**21**	**108**

Table 2 shows that 67 students (N=34, N=33) from Federal Government Higher Secondary School, Rawat and 41 students (N=20, N=21) from Federal Government Boys High School, Sangjani participated in this study.

Both of the schools had only two sections each for the subject of teaching "General Science" at 9th class so these four sections were taken as intact groups to participate in this study. One section in each school received treatment of problem-based instructional strategy (Experimental Group) while the other section was taught through lecture-based instructional strategy (Control Group) in both experiments.

3.3 RESEARCH DESIGN

A Pretest-Posttest Non-equivalent Control Group Design was employed to measure differences in academic achievement, problem solving capabilities and retention of subject matter of students under conditions of problem-based instructional strategy and lecture-based instructional strategy at secondary school level.

This Pretest-Posttest Non-equivalent Control Group Design can be represented as follows:

	E	=	O_1	T	O_2
	C	=	O_3	--	O_4

Where O_1 and O_3 = are the observations on **pretest**

O_2 and O_4 = are the observations on **posttest**

E = is the **Experimental Group**

C = is the **Control Group**

T = is the **Treatment**

In this case the first step was to measure both the groups. The treatment was then administered to one group and following the treatment both groups were measured again. The addition of the pretest measurement allowed researcher to address the problem of assignment bias that exists with all nonequivalent group researches.

This design is often used in psychology and social sciences. In this design, the experimental and control groups were selected as intact classes that may be very similar. In Federal Government schools that constituted the sample of the study, it was very difficult for the researcher to obtain equivalent experimental and control group through

randomization because the school administration did not allow the researcher to split classes, disturb class schedule or assemble scattered subjects at one place.

The two groups; experimental and control groups, were taught through different instructional strategies. The experimental group received the treatment of problem-based instructional strategy while control group was taught by the previously used strategy, named, lecture-based instructional strategy. The experiment was continued for 12 weeks.

This research study determined the effectiveness of instructional strategies on academic achievement, retention of subject matter and problem solving capabilities. The difference between the means of the O_1 and O_2 scores and the difference between the means of the O_3 and O_4 scores was tested at 0.05 level by applying independent sample *t*-test.

3.4 RESEARCH INSTRUMENTS

As a research instrument, the researcher developed three different types of tests to measure the following dependent variables.

1 Achievement Test (AT)

2 Problem Solving Capabilities Test (PSCT)

3 Retention Test (RT)

3.4.1 Achievement Test (AT)

Achievement was measured by determining the number of correct answers to the questions through the administration of pre-test and a post-test presented to all the participants in control group and experimental group. The pre-test and post-test reported in this research study, were focused on answering the multiple-choice questions (MCQ).

The pre-test consisted of 80 multiple-choice questions having each MCQ of one mark. The total marks of this test were 80. This pre-test was administered to determine baseline equivalency in prior knowledge of students in the problem-based and lecture-based treatment groups. The same test was used as post-test consisted of 80 multiple choice questions of 80 marks that required students to respond to near-transfer of information recall, and was administered to determine the differences if any in the mean performance on near transfer of information as a result of the instructional treatments (problem-based or lecture-based) administered.

3.4.2 Problem Solving Capabilities Test (PSCT)

Student problem solving capabilities were determined through the administration of researcher made problem solving capabilities test. That test comprised of 15 well-structured problems/scenario/investigations of daily life relevant to the course content. Those problems/scenario/investigations were developed for examining critical thinking skill, understanding, problem solving, self-evaluation, data gathering and learning skills of the students. Students had to find out solutions in each problems / scenario / investigations. The total marks of problem solving capabilities test were 60.

3.4.3 Retention Test (RT)

Learner retention of subject matter was measured by administering the retention test developed by the researcher by rearranging the 80 test items of achievement test. This test was administered three months after the post-test administered to students in both the problem-based and lecture-based instructional groups.

3.5 VALIDITY OF RESEARCH INSTRUMENTS

The validity of each of these instruments was established prior to data collection. Content validity of the achievement test (AT) was determined by comparing the individual questions to the instructional objectives of the lesson. The instrument had to measure each lesson objective. Initially, the researcher developed a test comprised of 120 test items from the selected four chapters of the textbook of "General Science" to measure the academic achievement of the students with the help of a table of specification. This test was validated through pilot testing and discussion with the Subject Specialists teaching the subject of "General Science" in Federal Government institutions and Test Development Specialists in National Educational Assessment System (NEAS), Ministry of Education, Islamabad for construct validity. The observations made by these experts about the quality of test items were removed and the researcher incorporated their suggestions. Finally through item analysis, 40 very difficult, very easy and poor items of the achievement test were deleted and 80 good items (Items with difficulty level of .40 to .70) were obtained and got approved from the supervisor of the researcher for administration. All the test items were based on the text of the units taught to the sample students.

The problem solving capabilities test (PSCT) was validated through pilot testing and discussion with the experts in the area of problem-based instructional strategy. The observations made by the experts were incorporated and got approved by the supervisor for administration.

A pilot test was conducted at two schools similar to those in the main experiment to test the lesson plans and instruments. Selection for the pilot test schools had the same criteria that the selection for the schools in the study.

3.6 RELIABILITY OF RESEARCH INSTRUMENTS

The split half method (odd-even) was used to test the reliability of achievement test (AT) by administering the test on selected group of students whom criteria of selection was the same as the selection of sample of the study. In split-halves method, the researcher divided the total number of items into two halves and then a correlation was obtained between these two halves. This obtained correlation estimated the reliability of each half of the test.

Then the researcher estimated the reliability of whole test by using a statistical correlation formula called as Spearman Brown Prophecy Formula. The graphical representation of Spearman Brown Prophecy formula is:

$$Pxx'' = 2Pxx'/1+Pxx'$$

Where Pxx" is the reliability coefficient for the whole test and Pxx' is the split-half correlation. The correlation between the two halves was .75 whereas the reliability for the total test was found to be .857 which was highly reasonable.

The reliability of problem solving capabilities test (PSCT) was tested by test-retest method in which the students were given the same test after a period of time. The consistency of responses between these tests was measured. This consistency of response estimated the reliability of problem solving capabilities test. The reliability of coefficient between the two administered tests was found to be .79 which was quite reasonable.

3.7 INDEPENDENT VARIABLES

The independent variable for this research study was the instructional strategy. These were lecture-based and problem-based instructional strategy.

3.7.1 Lecture-based Instructional Strategy

The lecture-based instructional treatment was centered on a combination of instructor-led lecturing and student-oriented practical activities. The instruction was initiated with a presentation of the instructional objectives for the class, and a "prior recall" activity as an event to secure the motivation of the students. Next, the instructor conducted a lecture in which the critical instructional content was presented to the students. A sample instructional content is given as under:

The existence of an element in different physical forms due to different arrangement of atoms in space is called allotropy. These different crystalline forms are called allotropes. The physical properties of allotropes are different but chemical properties are same. Carbon exists in nature in different allotropic forms; Diamond and Graphite are two main allotropes.

During the lecture, the instructor continued to provide descriptions of key instructional knowledge and skills, and examples of the application of the concepts in practical contexts.

The instructor continued to provide instructional content in the lecture-based format throughout the class session. The class session was concluded with a summary activity, in which the key instructional content was summarized for the class.

3.7.2 Problem-based Instructional Strategy

In problem-based instructional strategy, the students worked in small groups to acquire the conceptual knowledge and procedural skills needed to develop one or more plausible solutions to each of the problems presented to them. Each group of students (consisting of five to six students) met with the facilitator to discuss the problem. The facilitator presented a limited amount of information about the problem, and the group was charged with the task of identifying the different aspects of the problem by asking the facilitator questions to elicit information relevant to the problem. The students were engaged in the process of thinking and problem solving while confronting with the problems. Students develop the skills of thinking and problem solving such as questioning, planning problem finding activities, examining problem, analyzing results and generate solutions of the problem or scenario presented to them. A sample problem situation /scenario is given as under:

Arslan has a packet of lead pencils. Usually his mother used to sharpen his pencil for home work. One day his mother was busy in kitchen and he had to sharpen his pencil. He requested his mother to help him in sharpening the pencil. She asked him gently to do this by himself. He knew that the lead in the pencil is harder than its cover but as he sharpened the pencil, he observed that it sharpened very easily.

After presentation of problem/situation/scenario, the groups were then asked to find out, the key factors of the problem/situation/scenario, generate and refine hypotheses related to the problem's potential solution, and determine "learning issues" that were relevant. The groups were then asked to assign the tasks to each member of the group for researching each of the different "learning issues" they had identified. After each of the

group members had conducted the necessary research related to the "learning issue" they were assigned, the group members reported their findings to each other and used it to generate a formal solution to the problems.

3.7.3 Instructional Materials

Currently there is only one book recommended for both the 9th and 10th class in the institutions working under the umbrella of Federal Directorate of Education, Islamabad. This book consists of eleven chapters. The subject of "General Science" at 9th class consists of five chapters (Chapter 1, 2, 5, 7 & 9) while the other six chapters (3, 4, 6, 8, 10 & 11) are for class 10th.

This research study focused on the instructional objectives for 3 months course on the subject of "General Science" class 9th. The research study was conducted after the summer vacations so the chapter already taught (Chapter 1) was left out and the remaining four chapters were taken as an instructional material for problem-based instructional strategy and lecture-based instructional strategy. These four chapters were:

1. Our life and Chemistry (Chapter 2)
2. Microorganism and Diseases (Chapter 5)
3. Energy (Chapter 7)
4. Basic Electronics (Chapter 9)

Activity and Procedure during Presentation of Lesson

The students were engaged in some actual activities during the presentation and learning of lessons. Lessons were prepared and presented on different topics related to the

specified instructional material of 9th grade. Some activities done during the presentation of lessons were:

Lesson Topic: Bacterial Diseases and their Causes
(Activity of Preparing Slide containing Bacteria)

Resources and Material: General Science Textbook, Encyclopedia, Pictures of Bacteria, Other Bacteria related resources

Activity and Procedure:

A sterile petri dish containing the growing media nutrient agar was given to the students. This petri dish was not exposed to the external environment. The students were then asked to put some stuff in the perti dish that come off the lips. After exposing the dish, the students wrote their names on a small piece of masking tape and tapped off one side of their petri dish specimen. The teacher taped the dish shut and put it into incubator having around body temperature.

Next day, each student was handed out petri dish by the teacher. The students put their petri dishes again in the incubator after recording the observations. Another observation was made 48 hours later. The teacher handed out the petri dishes to the students for the last time. This action was taken 72 hours after the initial exposure of dishes for observation. Now the students took their final observations. The students made some conclusions after a class discussion. After discussion with the students, the teacher related and reviewed the bacterial types and diseases with the contents of the lesson already taught to them.

The teacher handed out each student a prepared slide containing bacteria for microscopic work. The students put the slide on the microscope stage and focus the

microscope. The students draw the picture viewed on microscope and used reference sources to identify and label the bacteria being viewed. After lab, the students discussed bacteria diseases and their causes.

Students conducted a poll to determine if people consider bacteria helpful or harmful. The students discussed ten health practices that deal with the illness caused by bacteria. They also composed a story about the disease caused by bacteria. The students were also asked to research the historical effects of major diseases caused by bacteria.

Lesson Topic: Elements for the Maintenance of Agriculture **(Activity of Photosynthesis)**

Resources and Material: Poster of Thylakoid with an electron transport chain, One fan, Light (Lamp), Tape, Chalk, Candy for each student, Red, blue and Yellow Construction paper or each student, Photocopy handouts and chlorophyll label-one per student.

Activity and Procedure:

In front of the room, the teacher placed the thylakoid poster on the chalk board and then a fan was put on one side of the poster. The fan was pointed in the opposite direction of the poster. Then the teacher taped the label "Glucose" of the other side of the fan and the candy was placed on it. Tape the Calvin cycle label on the cart. Now light was placed on the cart so that it shined on the thylakoid poster. Cut a hole with the ADP label from where 3rd phosphate went. The teacher taped the ADP level on top of the surge protector. Now the teacher taped the two photo-system labels on the top of the thylakoid poster. Two chlorophyll labels were placed on each student's desk. The teacher crumpled the red and blue colored papers into the tight round balls.

The teacher reviewed the purpose of photosynthesis with the students, the structure of chloroplast, light and dark reactions and the visible light spectrum. The teacher then asked the students to color that is reflected and some of them absorbed. The teacher asked the student why we felt hot in the sun when we wear black shirt instead of white shirt. The teacher handed out the color paper balls to three students standing in front of the room. These students pretended to be plants. The students were asked to throw these balls to you. The teacher caught the red ball and deflected the other two back to students. The teacher asked the students that what color you would be. Green of course, because red is absorbed and the reflected yellow and blue balls makes green.

The teacher demonstrated this activity with one student. The volunteer gently threw the red ball to a student in front of the class. The receiving student said out loud "I am chlorophyll and the light I absorb splits water to form oxygen gas, electron and hydrogen ions". The student's then ripped their water molecule paper and brought blue or red ball to the volunteer and walked to the electron transport chain with their two electrons and four hydrogen ions. In the end, the students span round to show that they were excited and said out loud "I am an excited electron that powers the electron transport chain". The students then finished sliding the electron to the end of the chain and said out loud "In photo-system I, the excited electron is stored in NADPH". The process then was repeated and other students were engaged in this type of activity.

3.7.4 Development of Lesson Plans

The researcher developed two versions of lesson plan. One version of lesson plan utilized the lecture-based instructional strategy while the second version of lesson plan utilized problem-based instructional strategy. Twenty four lesson plans for lecture-based instructional strategy (Appendix I) and twenty four problem / situations / scenario for problem-based instructional strategy (Appendix II) were developed with respect to four chapters taught during the experiment. The content for each lesson plan, across both the lecture-based instructional strategy and problem-based instructional strategy, was based on the same educational objectives in both the experiments.

Teachers used these lesson plans to develop problem solving skills in their students through the specified instructional strategy. The problem solving skills related to different lesson plans were as under:

1. **Abstraction**: It is a process of deriving higher concepts through the usage of real or concrete concepts. Abstraction is formed by reducing the information content relevant for a particular purpose. A strategy of simplification is used in abstraction in which concrete details were left undefined, vague or ambiguous. Abstraction also helps in developing effective communication between communication recipient and communicator through common experience.
2. **Brainstorming**: It is a group creativity skill for the solution of a problem through generating a large number of ideas. In a group brainstorming may provide benefits, such as enhancing work enjoyment, boosting morale and improving team work.

3. **Analysis**: It is a process of breaking complex topic into smaller parts to gain a better understanding of the topic.
4. **Hypothesis Testing**: It is an assumption of possible explanation to the problem and trying to prove or disprove that assumption.
5. **Literal Thinking**: It is skill of reaching solution to the problems through an indirect and creative approach using reasoning. It is more concerned with the movement of statements and ideas. Literal thinking is used by a person when he wants to move from one known idea to creating new ideas.
6. **Means-End Analysis**: It is a skill to control search in a problem solving. Through means-end analysis, an action is chosen which reduces the difference between current state and a goal state. The action is performed on the current state to produce a new state and the process is recursively applied to this new state and the goal state.
7. **Method of Focal Objects**: It is a problem solving skill involves synthesizing the apparently non-matching characteristics of different objects into something new.
8. **Reduction**: It is a skill of transforming one problem into another problem. This transformation is used to define complexity classes on a set of problems. Often, we try to solve a problem that is similar to a problem we have already solved. In these cases, the new problem can be quickly solved by transforming each instance of the new problem into instances of the old problem. These new problems can then be solved by using existing solutions, and then these

solutions are used to obtain final solution. This is perhaps the most obvious use of reduction.

9. **Research**: It is a skill for the search of knowledge through systematic investigation, with an open mind, to establish novel facts, usually using scientific method.
10. **Root Cause Analysis**: It is skill of identifying the root causes of problems or events. It is predicted through the practices of root cause analysis that problems are best solved by attempting to correct or eliminate root causes rather than addressing the obvious symptoms. Problem reoccurrences can be prevented by directing corrective measures at root cause.
11. **Trial and Error**: It is general skill of problem solving, fixing things for obtaining knowledge. The simple problems are often solved through trail and error. It works on the principle of guess and check, making a change and then trying again to reach the desired solution. (Dods, R. S., 1997)

All lesson plans and instruments related to the lesson plans were developed by the researcher. Format of the lesson plan was adapted from the Lesson Plan Builder Template, Georgia Learning Connections, Department of Education, Georgia.

3.7.5 Selection and Training of Teachers

Although the concept of problem-based instructional strategy is not new in the world, yet in Pakistan, our teachers in school do not apply this strategy. Availability of suitable teachers for teaching the experimental group through problem-based instructional strategy is not possible because most of the teachers teaching the subject of

"General Science" in both the schools were not aware of this strategy. The researcher himself took the responsibility to provide training to the teachers teaching the experimental group because he had been in touch with the theory and application of problem-based instructional strategy for the previous three years.

Four teachers (2 from F. G. Boys High School, Sangjani and 2 from F. G. Boys Higher Secondary School, Rawat) were selected in with the consultation of their concerned principals keeping in view their equivalent background knowledge and experience in teaching the subject of "General Science". Out of these four teachers, two teachers (1 from both the schools) were for teaching the control group through lecture-based instructional strategy while the other two (1 from both the schools) were for facilitating the experimental group through problem-based instructional strategy. Only the latter two teachers were given the training for teaching/facilitating to the experimental group.

The researcher organized a training period of two weeks in F. G. Boys High School, Sangjani. The teachers / facilitators attended a twelve day professional development training program on problem-based instructional strategy before they facilitated the experimental group. Due to the shortage of time and other factors related to the training of teachers, the training time was restricted only to two hours per day. The aim of this training program was to develop in facilitators the fundamental knowledge and skills necessary to function effectively in the PBIS environment. In training program, the teachers were prepared to use problem-based instructional strategy. They discussed the methods and procedures of supporting and engaging problem-based instructional

strategy in classroom settings. Some of the key ideas discussed during the training program include:

1. Effective Teaching Learning process and factors affecting learning
2. Difference between teaching and facilitating
3. Facilitating a problem-based instructional class
4. Stages in problem-based instructional strategy
5. Levels in problem-based instructional strategy
6. Students learning process in problem-based instructional strategy
7. Finding resources for solution of problem
8. Helping students in learning through removing obstacles
9. Assessment procedures in problem-based instructional strategy
10. Developing problem solving and thinking skills in students

Before going to work as facilitator in the classroom, both the teachers had experienced the problem-based instructional strategy.

3.8 PARTICIPANTS

The participants in the study were 67 students (N=33 in Control Group and N=34 in Experimental Group) 'studying in F. G. Boys Higher Secondary School, Rawat, Islamabad and 41 students (N=21 in Control Group and N=20 in Experimental Group) of 9^{th} class who attended F.G. Boys High School, Sangjani, Islamabad. One section in each school was given the treatment of problem-based instructional strategy, while the other

section in each school was taught through lecture-based instructional strategy. The study was conducted during the regularly scheduled class periods of "General Science".

3.9 PRESENTATION PROCEDURES IN PBIS AND LBIS

This study was an experimental in nature in which two experiments were conducted at the same time. One experiment was conducted in F. G. Boys Higher Secondary School, Rawat, Islamabad while the other was conducted in F. G. Boys High School, Sangjani, Islamabad. The participants in the study were assigned within sections to two groups in each school. One group was problem-based instructional group receiving the problem-based instructional strategy, and the other group was lecture-based instructional group receiving the instructor-led direct instruction.

Problem-based instructional class was divided into groups having 5 students in each group. These groups comprised of two high achievers, one average and two low achievers. Thus there was heterogeneous group of students with mixed abilities in a single group. They were named as group A, B, C, D ..... and the students in these groups were allocated roll number 1, 2, 3, 4, ... randomly. The nomenclature for the students was like A_1, A_2, A_3, ...

In problem-based instructional strategy, the students themselves ran the class sessions. The proceeding of the class was chaired by one of the student while another did the scoring. These roles of the students were changed after each problem presentation. A facilitator, who was trained in problem-based instructional strategy, remained present there. The first part of the class session included debriefing of the problem presented in the

previous period. In the second part of the class session, new problem was briefed to the students.

In briefing part, the students were given a written scenario. The chairman read out the problem or scenario. The students in the groups were asked to identify key words and phrases from the scenario that needed to be implicated. After identification, the groups discussed the issues raised in the problem presented to them. The students in the groups set their own learning objectives. A facilitator remained present in the class to ensure that the groups stay focused on solving problem and achieving the learning objectives set by them. The problem writer prepared a confidential document at the time of identifying problem situation. This confidential document was provided to the facilitator, showing all the issues that were expected to be identified by the students.

The students then left the class session. They learn with the help of different resources available to them. These learning resources were identified by the problem writers as a part of problem solving process and students decided what learning resources they required. The teacher as a facilitator remained present in the class to make sure the availability of learning resources like laboratory facilities, library back-up, internet and other computing access.

After the first part of the group session, the groups presented the results of their findings in a single group activity. Sometimes, those findings were also presented in an open forum in which two or more than two groups participated. A critique was also provided on those findings.

In lecture-based instructional class, the teacher made the necessary seating arrangement so that all the students had easy eye contact with the teacher and then formally

started the lesson. The whole class worked as a single group and the teacher presented the required amount of information to the students.

In both the instructional strategies, the focus of the instruction was on the development of thinking and problem solving skill. The possible indicators of thinking and problem solving skills stressed during the two instructional strategies were:

1. Questioning
2. Planning problem finding activities
3. Examining problem
4. Analyzing results
5. Generate solutions

The instructions were being administered over the course of 12-week, and during each week students dedicated three hours of instructional time to participate in the study. The students in problem-based instructional class received the treatment of problem-based instructional strategy for three hours per week on the subject of "General Science" while the students in lecture-based instructional class received the same amount of time for teaching the subject of "General Science" through lecture-based instructional strategy. In addition, they completed the homework assignment and tests associated with the instructional content taught during the classroom session.

Students in the problem-based instructional group and lecture-based instructional group received their instruction on Mondays to Saturday from 9:30 a.m. to 10:00 a.m. in F. G. Boys Higher Secondary School, Rawat, Islamabad while the students of both instructional groups in F. G. Boys High School, Sangjani, Islamabad received their

instruction also on the same days i.e. Monday to Saturday from 12:00 p.m. to 12:30 p.m. All the instructional groups received their instruction in their classrooms already assigned for teaching the subject of "General Science" at F. G. Boys Higher Secondary School, Rawat, Islamabad and F.G. Boys High School, Sangjani, Islamabad.

3.10 DATA COLLECTION

During the period of data collection, students utilized about 2 hours and 15 minutes of instructional time. Instructional treatments were given for half an hour to both the instructional groups and the additional time commitment (one hour and 45 minutes) dedicated to data collection outside of the scheduled class periods on the last day of the treatment. In this research study, data collection was done through the administration of three different types of tests.

1. Achievement Test (AT)
2. Problem Solving Capabilities Test (PSCT)
3. Retention Test (RT)

Achievement test and problem solving capabilities test were administered to obtain pretest scores just before the beginning of treatment to problem-based instructional group in both the experiments. The experiment continued for twelve weeks. After the completion of treatment (teaching) of twelve weeks, the post-test was administered immediately to obtain posttest scores in achievement test and problem solving capabilities test from experimental and control groups in both the experiments.

After twelve weeks of post-test, retention test was administered to problem-based instructional group and lecture-based instructional group in both the experiments to obtain the retention of subject matter among the students.

3.11 DATA ANALYSIS

Pre-test, post-test and retention test scores of the sample were obtained and lists were prepared for each problem-based instructional group and lecture-based instructional group in both the experiments.

After preparing lists of pre-test, post-test, problem solving capabilities test and retention test, mean, standard deviation, difference of mean were computed using SPSS. Significance of difference between the mean scores on pre-test, post-test and retention test in problem-based instructional group and lecture-based instructional group in both the experiments were tested at .05 level by applying independent sample t-test.

For statistical analysis, the formula followed by Garrett (1997) and Gay (2000) was applied.

Standard Deviation = s = $\sigma = \sqrt{\frac{\Sigma(x - \bar{x})^2}{n}}$ =

Mean = Average = M = $\bar{x} = \frac{\Sigma x}{n}$ =

CHAPTER 4

PRESENTATION AND ANALYSIS OF DATA

The first three chapters introduced the problem of the study, reviewed the related literature and outlined the methodology of the study respectively. This chapter deals with presentation and analysis of data on different aspects of the study. The data collected through pre-test, post-test, retention test and problem solving capabilities test was analyzed through descriptive statistics and inferential analysis.

In the 1st phase the data is analyzed descriptively. In Inferential statistical analysis, the researcher used computer software named Statistical Program for Social Sciences (SPSS). In this program, the data were analyzed through computer and hypotheses were tested through mean and independent sample *t*-test. The results were then interpreted.

Obtained results along with the analysis and interpretation are presented in the following pages.

Table 3: Group statistics on mean posttest academic achievement scores in FGBHSS, Rawat

Group	N	Mean	SD	SE_M
Control	34	45.79	5.290	.907
Experimental	33	56.30	5.817	1.013

The above table 3 reveals the means, standard deviations and standard error of the means of two groups. The mean of the control group was found 45.79 and that of experimental group was 56.30. The standard deviations were 5.290 and 5.817 respectively. The standard errors of the means were found 0.907 and 1.013 respectively.

It revealed that as far as the mean, SD and SE_M of both the groups were concerned; they were very close to each other.

HYPOTHESIS # 1

There is no significant difference between the mean pre-test academic achievement scores of the students to be taught through problem-based instructional strategy and the students to be taught through lecture-based instructional strategy in FGBHSS, Rawat.

ANALYSIS OF PROBLEM

1. $H_0 : \mu_1 = \mu_2$
2. $H_1 : \mu_1 \neq \mu_2$
3. $\alpha = 0.05$ with df = 65
4. **DECISION RULE Reject H_0 if t > 2.000** (Macmillan, T, 2004)

Table 4: Significance of difference between the mean pretest academic achievement scores in FGBHSS, Rawat

Group	M	SD	SE_D	t	p
Control	30.35	5.274			
			1.304	.085	.933
Experimental	30.24	5.397			
df=65				t at .05=2.000	

As the table 4 above indicates, the observed difference of .111 in mean pretest achieved scores of the control and experimental groups which is not statistically significant at .05 level of significance. Therefore the null hypothesis that "there is no significant difference between the mean pre-test academic achievement scores of the students to be taught through problem-based instructional strategy and the students to be

taught through lecture-based instructional strategy" was accepted. Therefore both the groups did not differ in their achievement before the experiment.

Table 5: Group statistics on mean pre-test Problem Solving Capabilities scores in FGBHSS, Rawat

Group	N	Mean	SD	SE_M
Control	34	9.59	6.106	1.047
Experimental	33	9.58	6.515	1.134

The above table 5 reveals the means, standard deviations and standard error of the means of two groups. The mean of the control group was found 9.59 and that of experimental group was 9.58. The standard deviations were 6.106 and 6.515 respectively. The standard errors of the means were found 1.047 and 1.134 respectively. It revealed that as far as the mean, SD and SE_M of both the groups were concerned; they were very close to each other.

HYPOTHESIS # 2

There is no significant difference between the mean pre-test problem solving capabilities of the students to be taught through problem-based instructional strategy and the students to be taught through lecture-based instructional strategy in FGBHSS, Rawat.

ANALYSIS OF PROBLEM

1. $H_0 : \mu_1 = \mu_2$
2. $H_1 : \mu_1 \neq \mu_2$
3. $\alpha = 0.05$ with $df = 65$
4. **DECISION RULE Reject H_0 if $t > 2.000$**

Table 6: Significance of difference between the mean pre-test Problem Solving Capabilities scores in FGBHSS, Rawat

Group	M	SD	SE_D	t	p
Control	9.59	6.106			
			1.542	.008	.994
Experimental	9.58	6.515			

df=65 t at .05=2.000

The above table 6 reveals that the observed difference .012 between the mean scores of the control and experimental groups on pre-test problem solving capabilities is insignificant at 0.05 level of significance. Therefore the null hypothesis that "There is no significant difference between the mean pre-test problem solving capabilities of the students to be taught through problem-based instructional strategy and the students to be taught through lecture-based instructional strategy" was accepted. It was established that the significant difference was not found between the pre-test problem solving capabilities scores of the control and experimental groups and both the groups were equal regarding problem solving capabilities.

Table 7: Group statistics on mean posttest academic achievement scores in FGBHSS, Rawat

Group	N	Mean	SD	SE_M
Control	34	45.79	5.290	.907
Experimental	33	56.30	5.817	1.013

The above table 7 reveals the means, standard deviations and standard error of the means of two groups. The mean of the control group was found 45.79 and that of experimental group was 56.30. The standard deviations were 5.290 and 5.817 respectively. The standard errors of the means were found 0.907 and 1.013 respectively. It revealed that as far as the mean, SD and SE_M of both the groups were concerned; they were not close to each other.

HYPOTHESIS # 3

There is no significant difference between the post-test academic achievement scores of the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy in FGBHSS, Rawat.

ANALYSIS OF PROBLEM

1. $H_0 : \mu_1 = \mu_2$
2. $H_1 : \mu_1 \neq \mu_2$
3. $\alpha = 0.05$ with $df = 65$
4. **DECISION RULE Reject H_0 if $t > 2.000$**

Table 8: Significance of difference between the mean posttest academic achievement scores in FGBHSS, Rawat

Group	M	SD	SE_D	t	p
Control	45.79	5.290			
			1.358	7.740*	.000
Experimental	56.30	5.817			
df=65				t at .05=2.000	

The above table 8 shows that the observed difference of 10.509 between the mean scores of the control and experimental groups on post-test academic achievement is highly significant at 0.05 level of significance. Therefore, the null hypothesis that "There is no significant difference between the mean post-test academic achievement scores of the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy" was rejected. It was established that highly significant difference was found between the posttest academic achievement of the control and experimental groups and the experimental group performed better on academic achievement test than the control group.

Table 9: Group statistics on mean post-test Problem Solving Capabilities scores in FGBHSS, Rawat

Group	N	Mean	SD	SE_M
Control	34	10.26	5.869	1.006
Experimental	33	24.18	6.971	1.213

The above table 9 reveals the means, standard deviations and standard error of the means of two groups. The mean of the control group was found 10.26 and that of experimental group was 24.18. The standard deviations were 5.869 and 6.971 respectively. The standard errors of the means were found 1.006 and 1.213 respectively. It revealed that as far as the mean, SD and SE_M of both the groups were concerned; they were not close to each other.

HYPOTHESIS # 4

There is no significant difference between the mean post-test problem solving capabilities of the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy in FGBHSS, Rawat.

ANALYSIS OF PROBLEM

1. $H_0 : \mu_1 = \mu_2$
2. $H_1 : \mu_1 \neq \mu_2$
3. $\alpha = 0.05$ with df = 65
4. **DECISION RULE Reject H_0 if t > 2.000**

Table 10: Significance of difference between mean post-test Problem Solving Capabilities scores in FGBHSS, Rawat

Group	M	SD	SE_D	t	p
Control	10.26	5.869			
			1.572	8.850*	.000
Experimental	24.18	6.971			
df=65				t at .05=2.000	

The above table 10 indicates the observed difference 13.917 in mean scores of the control and experimental groups on post-test problem solving capabilities test. It is highly significant at 0.05 level of significance. Therefore the null hypothesis that "There is no significant difference between the mean post-test problem solving capabilities scores of the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy" was rejected. It was established that the post-test problem solving capabilities scores of experimental group was significantly higher than the scores of the control group.

Table 11: Group statistics on retention scores in FGBHSS, Rawat

Group	N	Mean	SD	SE_M
Control	34	29.59	5.533	.949
Experimental	33	54.85	5.985	1.042

The above table 11 reveals the means, standard deviations and standard error of the means of two groups. The mean of the control group was found 29.59 and that of experimental group was 54.85. The standard deviations were 5.533 and 5.985 respectively. The standard errors of the means were found .949 and 1.042 respectively. It revealed that as far as the mean, SD and SE_M of both the groups were concerned; they were not close to each other.

HYPOTHESIS # 5

There is no significant difference between the mean retention posttest scores of the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy in FGBHSS, Rawat.

ANALYSIS OF PROBLEM

1. $H_0 : \mu_1 = \mu_2$
2. $H_1 : \mu_1 \neq \mu_2$
3. $\alpha = 0.05$ with df = 65
4. **DECISION RULE Reject H_0 if t > 2.000**

Table 12: Significance of difference between the mean scores of retention test in FGBHSS, Rawat

Group	M	SD	SE_D	t	p
Control	29.59	5.533			
			1.408	17.947*	.000
Experimental	54.85	5.985			

df=65 t at .05=2.000

The above table 12 shows the observed difference 25.260 between the mean scores of the control and experimental groups on retention of subject matter. It was found highly significant at 0.05 level of significance. Therefore, the null hypothesis that "There is no significant difference between the mean retention posttest scores of the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy" was rejected. The students who were taught with the problem-based instructional strategy retained more as compared to the students in the control group taught with the lecture-based instructional strategy.

Table 13: Group statistics on mean pretest academic achievement scores in FGBHS, Sangjani

Group	N	Mean	SD	SE_M
Control	20	33.45	6.151	1.375
Experimental	21	33.76	6.602	1.441

The above table 13 reveals the means, standard deviations and standard error of the means of two groups. The mean of the control group was found 33.45 and that of experimental group was 33.76. The standard deviations were 6.151 and 6.602 respectively. The standard errors of the means were found 1.375 and 1.441 respectively. It revealed that as far as the mean, SD and SE_M of both the groups were concerned; they were very close to each other.

HYPOTHESIS # 6

There is no significant difference between the mean pre-test academic achievement scores of the students to be taught through problem-based instructional strategy and the students to be taught through lecture-based instructional strategy in FGBHS, Sangjani.

ANALYSIS OF PROBLEM

1. $H_0 : \mu_1 = \mu_2$
2. $H_1 : \mu_1 \neq \mu_2$
3. $\alpha = 0.05$ with df = 39
4. **DECISION RULE Reject H_0 if t > 2.021**

Table 14: Significance of difference between the mean pretest academic achievement scores in FGBHS, Sangjani

Group	M	SD	SE_D	t	p
Control	33.45	6.151			
			1.995	.156	.877
Experimental	33.76	6.602			

df=39 t at .05=2.021

The above table 14 indicates that the observed difference .312 in mean scores of the control and experimental groups on pre-test academic achievement is not statistically significant at 0.05 level of significance. Therefore, the null hypothesis that "There is no significant difference between the mean pre-test academic achievement scores of the students to be taught through problem-based instructional strategy and the students to be taught through lecture-based instructional strategy" was accepted. It was established that both the groups did not differ in their achievement before the experiment. This result verifies the result of the experiment conducted in FGBHSS, Rawat.

Table 15: Group statistics on mean pre-test Problem Solving Capabilities scores in FGBHS, Sangjani

Group	N	Mean	SD	SE_M
Control	20	10.55	5.916	1.323
Experimental	21	11.05	6.184	1.350

The above table 15 reveals the means, standard deviations and standard error of the means of two groups. The mean of the control group was found 10.55 and that of experimental group was 11.05. The standard deviations were 5.916 and 6.184 respectively. The standard errors of the means were found 1.323 and 1.350 respectively. It revealed that as far as the mean, SD and SE_M of both the groups were concerned; they were very close to each other.

HYPOTHESIS # 7

There is no significant difference between the mean pre-test problem solving capabilities of the students to be taught through problem-based instructional strategy and the students to be taught through lecture-based instructional strategy in FGBHS, Sangjani.

ANALYSIS OF PROBLEM

1. $H_0 : \mu_1 = \mu_2$
2. $H_1 : \mu_1 \neq \mu_2$
3. $\alpha = 0.05$ with df = 39
4. **DECISION RULE Reject H_0 if t > 2.021**

Table 16: Significance of difference between mean pre-test Problem Solving Capabilities scores in FGBHS, Sangjani

Group	M	SD	SE_D	t	p
Control	10.55	5.916			
			1.892	.263	.794
Experimental	11.05	6.184			

df=39 t at .05=2.021

The above table 16 reveals that the observed difference .498 in mean scores of the control and experimental groups on pre-test problem solving capabilities is not statistically significant at 0.05 level of significance. Therefore, the null hypothesis that "There is no significant difference between the pre-test problem solving capabilities of the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy" was accepted. It was established that the significant difference was not found between the pre-test problem solving capabilities scores of the control and experimental groups and this result verified the result of the experiment conducted in FGBHSS, Rawat.

Table 17: Group statistics on mean posttest academic achievement scores in FGBHS, Sangjani

Group	N	Mean	SD	SE_M
Control	20	45.90	5.562	1.244
Experimental	21	54.90	7.719	1.685

The above table 17 reveals the means, standard deviations and standard error of the means of two groups. The mean of the control group was found 45.90 and that of experimental group was 54.90. The standard deviations were 5.762 and 7.719 respectively. The standard errors of the means were found 1.244 and 1.685 respectively. It revealed that as far as the mean, SD and SE_M of both the groups were concerned; they were not close to each other.

HYPOTHESIS # 8

There is no significant difference between the mean post-test academic achievement scores of the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy in FGBHS, Sangjani.

ANALYSIS OF PROBLEM

1. $H_0 : \mu_1 = \mu_2$
2. $H_1 : \mu_1 \neq \mu_2$
3. $\alpha = 0.05$ with df = 39
4. **DECISION RULE Reject H_0 if t > 2.021**

Table 18: Significance of difference between the mean posttest academic achievement scores in FGBHS, Sangjani

Group	M	SD	SE_D	t	p
Control	45.90	5.562			
			2.111	4.267*	.000
Experimental	54.90	7.719			

df=39 t at .05=2.021

The above table 18 indicates that the difference 9.005 between the mean scores of the control and experimental groups on post-test academic achievement is highly significant at 0.05 level of significance. Hence, it was discovered that there was a significant difference between the scores of control and experimental groups, and the null hypothesis that "There is no significant difference between the mean post-test academic achievement scores of the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy" was rejected. This result also verified the result of the experiment conducted in FGBHSS, Rawat.

Table 19: Group statistics on mean post-test Problem Solving Capabilities in FGBHS, Sangjani

Group	N	Mean	SD	SE_M
Control	20	12.30	5.536	1.238
Experimental	21	25.95	7.338	1.601

The above table 19 reveals the means, standard deviations and standard error of the means of two groups. The mean of the control group was found 12.30 and that of experimental group was 25.95. The standard deviations were 5.536 and 7.338 respectively. The standard errors of the means were found 1.238 and 1.601 respectively. It revealed that as far as the mean, SD and SE_M of both the groups were concerned; they were not close to each other.

HYPOTHESIS # 9

There is no significant difference between the mean post-test problem solving capabilities of the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy in FGBHS, Sangjani.

ANALYSIS OF PROBLEM

1. $H_0 : \mu_1 = \mu_2$
2. $H_1 : \mu_1 \neq \mu_2$
3. $\alpha = 0.05$ with df = 39
4. **DECISION RULE Reject H_0 if t > 2.021**

Table 20: Significance of difference between the mean post-test Problem Solving Capabilities in FGBHS, Sangjani

Group	M	SD	SE_D	t	p
Control	12.30	5.536			
			2.038	6.699*	.000
Experimental	25.95	7.338			

df=39 t at .05=2.021

The above table 20 reveals the difference 13.652 in means of the control and experimental groups on post-test problem solving capabilities. It was found highly significant at 0.05 level of significance. Hence, it was discovered that there was a significant difference between the mean scores of the control and the experimental groups on post-test problem solving capabilities, and the null hypothesis that "there is no significant difference between the mean post-test problem solving capabilities of the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy" was rejected. It was established that the post-test performance on problem solving capabilities of experimental group was significantly higher than the performance of the control group. This result also verified the result of the experiment conducted in FGBHSS, Rawat.

Table 21: Group statistics on mean retention posttest scores in FGBHS, Sangjani

Group	N	Mean	SD	SE_M
Control	20	32.45	5.763	1.289
Experimental	21	52.81	7.501	1.637

The above table 21 reveals the means, standard deviations and standard error of the means of two groups. The mean of the control group was found 32.45 and that of experimental group was 52.81. The standard deviations were 5.763 and 7.501 respectively. The standard errors of the means were found 1.289 and 1.637 respectively. It revealed that as far as the mean, SD and SE_M of both the groups were concerned; they were not close to each other.

HYPOTHESIS # 10

There is no significant difference between the mean retention posttest scores of the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy in FGBHS, Sangjani.

ANALYSIS OF PROBLEM

1. $H_0 : \mu_1 = \mu_2$
2. $H_1 : \mu_1 \neq \mu_2$
3. $\alpha = 0.05$ with df = 39
4. **DECISION RULE Reject H_0 if t > 2.021**

Table 22: Significance of difference between mean retention posttest scores in FGBHS, Sangjani

Group	M	SD	SE_D	t	p
Control	32.45	5.763			
			2.097	9.711*	.000
Experimental	52.81	7.501			

df=39 t at .05=2.021

The above table 22 indicates the observed difference 20.360 in means of the control and experimental groups on retention of subject matter. It was found highly significant at 0.05 level of significance. Hence, it was discovered that there was a significant difference between the mean scores of the control and the experimental groups on retention of subject matter, and the null hypothesis that "There is no significant difference between the mean retention posttest scores of the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy" was rejected. The students who were taught with the problem-based instructional strategy retained more as compared to the students in the control group taught with the lecture-based instructional strategy and this result also verifies the result of the experiment conducted in FGBHSS, Rawat.

Table 23: Levene test statistics to find out the equality of variance on pretest scores of the control and experimental groups in FGBHSS, Rawat

Pretest	Levene test of Equality of Variance	
	F	Sig.
Academic achievement	.008	.929
Problem Solving Capabilities	.602	.440

Alpha Level: 0.05

The above table 23 reveals the measures of homogeneity to apply t-test on the pretest scores. The significance of the Levene test on pretest academic achievement and problem solving capabilities was found .929, and .440 respectively. The Levene statistics on these two tests were not found significant. It was found above than 0 .05 level ($p > .05$) and it was concluded that variance of the pretest scores on academic achievement test and problem solving capabilities test were equal.

Table 24: Levene test statistics to find out the equality of variance on posttest scores of the control and experimental groups in FGBHSS, Rawat

Post-test	Levene test of Equality of Variance	
	F	Sig.
Academic achievement	.665	.418
Problem Solving Capabilities	.735	.395
Retention test	.164	.687

Alpha Level: 0.05

The above table 24 reveals the measures of homogeneity to apply t-test on the pretest scores. The significance of the Levene test on post-test academic achievement and problem solving capabilities was found .418, and .395 respectively. The significance of the Levene test on retention test was .687. The Levene statistics on these three tests were not found significant. It was found above than 0 .05 level ($p > .05$) and it was concluded that variance of post-test scores of academic achievement and problem solving capabilities and retention test were equal.

Table 25: Levene test statistics to find out the equality of variance on pretest scores of the control and experimental groups in FGBHS, Sangjani

Pretest	Levene test of Equality of Variance	
	F	Sig.
Academic achievement	.107	.745
Problem Solving Capabilities	.221	.641

Alpha Level: 0.05

The above table 25 reveals the measures of homogeneity to apply t-test on the pretest scores. The significance of the Levene test on pretest academic achievement and problem solving capabilities was found .745, and .641 respectively. The Levene statistics on these two tests were not found significant. It was found above than 0 .05 level ($p > .05$) and it was concluded that variance of the pretest scores on academic achievement test and problem solving capabilities test were equal.

Table 26: Levene test statistics to find out the equality of variance on posttest scores of the control and experimental groups in FGBHS, Sangjani

Post-test	Levene test of Equality of Variance	
	F	Sig.
Academic achievement	2.957	.093
Problem Solving Capabilities	2.161	.150
Retention test	1.153	.290

Alpha Level: 0.05

The above table 26 reveals the measures of homogeneity to apply t-test on the pretest scores. The significance of the Levene test on post-test academic achievement and problem solving capabilities was found .093, and .150 respectively. The significance of the Levene test on retention test was .290. The Levene statistics on these three tests were not found significant. It was found above than 0 .05 level ($p > .05$) and it was concluded that variance of post-test scores of academic achievement, problem solving capabilities and retention test were equal.

DISCUSSION

In this 21st century, science and technology has emerged as the most important subjects in our daily life, so as the subject of "General Science". Due to its importance and to improve the standard of teaching "General Science", it was necessary to conduct a study for approving a suitable instructional strategy for teaching the subject of General Science. Therefore, a study was conducted in which the researcher examined the effectiveness of problem-based instructional strategy and lecture-based instructional strategies on students' academic achievement, retention of subject matter and problem solving capabilities at secondary school level in the subject of general science. This study was experimental in nature and the obtained data through the experiment was analyzed, interpreted and conclusions were drawn.

Both the experimental and control groups to be taught through problem-based instructional strategy and to be taught through lecture-based instructional strategy respectively were compared on variable of pretest. Statistical analysis of mean pretest academic achievement data from both the groups showed that no significance of difference existed between the two groups with respect to pretest academic achievement. Therefore, the null hypothesis that "There is no significant difference between the mean pre-test academic achievement scores of the students to be taught through problem-based instructional strategy and the students to be taught through lecture-based instructional strategy" was accepted. Therefore both the groups were equal in their academic achievement before the experiment.

Statistical analysis of post-test academic achievement scores from both control and experimental groups did not support the hypothesis that there is no significant difference between the mean post-test academic achievement scores of the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy. The students in lecture-based instructional group remained mostly passive because this instruction was more consistent with the focus on transferring of knowledge and information for stated instructional objectives. The students in problem-based treatment group remained active during the teaching/learning process. Therefore, these students were anticipated to be more oriented towards solving complex, unfamiliar problem through the application of hypothesis driven reasoning skills. So, it appeared sensible that data should reject this hypothesis. Therefore, it is concluded that students in problem-based instructional group were well-equipped to perform efficiently on recall of near transfer of information.

This was also found by the research studies conducted by Chang, et al. (1995); Albanese & Mitchell, (1993); Kaufman & Mann, (1998); Login et al., (1996) on the impact of problem-based instructional strategy on students post-test academic achievement in which they found that there were statistically significant differences in students post-test academic achievement when compared with the students receiving lecture-based instructional strategy. In a meta-analysis of English language research done by Albanese and Mitchell (1993) found that the students in problem-based instructional strategy performed better on recall of near transfer of information in basic science examination as compared with traditional students. Similarly, Vernon & Blake (1993) in their meta-analysis found that the achievement of medical students in problem-based

instructional strategy on factual and clinical knowledge is significantly higher from the students in lecture-based instructional strategy.

There are a number of other research studies similar to the two meta-analysis cited above where it was found that there was statistically significant difference existed in posttest academic achievement scores between the students received problem-based instructional treatment and the students taught through lecture-based instructional strategy. Colliver (2000) in his research study on the impact of problem-based instructional strategy on students' post-test academic achievement concluded that problem-based instructional strategy improved more declarative knowledge and clinical performance of the students than lecture-based instructional strategy. A research study conducted by Albano, et al. (1993) on the difference of knowledge acquisition in medical schools graduates concluded that the problem-based instructional strategy had greater influence on the final level of knowledge acquisition in medical school graduates than the other variety of instructional strategies being used including lecture-based instructional strategy.

Statistical analysis of mean problem solving capabilities scores from both the groups to be taught through problem-based instructional strategy and to be taught through lecture-based instructional strategy, it was found that no significance of difference existed between the two groups with respect to pretest problem solving capabilities. Therefore, the null hypothesis that "There is no significant difference between the mean pre-test problem solving capabilities scores of the students to be taught through problem-based instructional strategy and the students to be taught through lecture-based instructional

strategy" was accepted. Therefore both the groups were equal in their problem solving capabilities before the experiment.

Statistical analysis of the data on problem solving capabilities scores did not support the hypothesis that, "there is no significant difference between the post-test problem solving capabilities scores of the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy". The data gathered on posttest problem solving capabilities contradicted the hypothesis. It was found that there was a significant difference existed between the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy on problem solving capabilities scores.

The statistical analysis of students retention level showed that the students of problem-based instructional strategy had overall higher retention of subject matter than the students of lecture-based instructional strategy. This assumption is appeared to be reasonable, since the students in problem-based instructional treatment are confronted with a comparatively high level of innovative factors in their learning experiences than the students of lecture-based instructional strategy. This finding did not support the hypothesis that, "There is no significant difference between the retention of subject matter among the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy".

Gordon and Colleagues (2001) similarly found that the students learning through problem-based instructional strategy value the student-centered nature of problem-based learning, including information seeking, high levels of challenge, group work, and personal relevance of the material.

Brown et al. (1983) and Brown, Collins and Duguid (1989) in their research studies concluded that students in problem-based instructional strategy prepared themselves to solve their real world problems through the application of their understanding of general science concepts and principles. Gallagher, Stepien and Rosenthal (1992) concluded through the limited literature review on problem-based instructional strategy that the students in problem-based instructional strategy were superior at knowledge application, problem definition and problem solution than the students in lecture-based instructional strategy.

Moreover, the research reported up-to-date concluded that students demonstrated active lifelong learning in problem-based instructional strategy when the teachers provide them facilitation, clarification, correction, elaboration and creation of such an environment in which students support one another through collaboration, ideas sharing and problem solving.

The results of this study revealed that problem-based instructional strategy enhances the academic achievement, problem solving skills and retention of subject matter in 9^{th} class students. Therefore, it is suggested that high school teachers use problem-based instructional strategy to improve students' lifelong learning skill by going beyond teaching content to teaching students how to learn.

The overall results of the study indicated that problem-based instructional strategy not only increased the average academic achievement of 9^{th} grade male students in the subject of general science but also improved the problem solving capabilities of the students.

The results of the study showed that problem-based instructional strategy increased average retention of subject matter of 9th grade male student in the subject of general science than the students taught through lecture-based instructional strategy.

The experiments were carried out in rural area schools of Islamabad district. Hence the results of the study were therefore, applicable in rural area schools working under Federal Directorate of Education, Islamabad.

CHAPTER 5

SUMMARY, FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 SUMMARY

This study was designed to find out the effectiveness of problem-based versus lecture-based instructional strategies on the achievement, retention and problem solving capabilities of secondary school students in the subject of General Science. The major objectives of the study were (a)-to compare the impact of problem-based instructional strategy and lecture-based instructional strategy on the academic achievement of secondary school students, (b)-to determine the comparative effect of problem-based instructional strategy and lecture-based instructional strategy for the enhancement of retention of the subject matter among the secondary school students, and (c)-to compare the effect of problem-based instructional strategy and lecture-based instructional strategy on the development of problem solving capabilities among secondary school students.

Population: The 6303 male secondary school students studying the subject of General Science in Islamabad district constituted the population of the study.

Sample: The study was conducted in two different schools and the students of 9^{th} class of F. G. Boys Higher Secondary School, Rawat, (Experiment 1) and F. G. Boys High School, Sangjani, Islamabad (Experiment 2) were taken as sample for the research study. The sample consisted of 108 students from both the institutions.

The sample students were assigned to two groups i.e. control group taught through lecture-based instructional strategies and experimental group taught through problem-based instructional strategy. Control group was comprised of 34 and 20 students while the experiment group was of 33 and 21 students respectively.

Design and Procedure: The design of the study was pretest posttest non-equivalent control group design. There was a different treatment pattern applied during the experiment. Four different teachers in their intact classes taught all the four groups. During the experiment period of 12-week duration, the experimental group received the treatment of independent variable i.e. problem-based instructional strategy. Meanwhile the control group was taught through another form of independent variable i.e. lecture-based instructional strategy. Other variables were kept constant as far as possible.

Collection of data: Both the control and experimental groups were given pretest in each schools before the start of the experiment to find out the equivalency of the groups. In order to find out treatment effects, a teacher made posttest was administered to both experimental and control groups immediately after the treatment period was over. The purpose of this test was to measure the academic achievement of students. Another posttest was administered to measure the problem solving capabilities of students constituting the sample of the study. Twelve weeks after the posttest, a retention test was administered to find the retention of the subject matter. There was no dropout rate. Students were almost regular. Final data were collected from 108 students, 34 and 20 subjects from control group and 33 and 21 subjects from experimental group respectively.

Analysis of data: The achievement scores of the sample were obtained as a result of the pre-test, post-test and retention test. After obtaining the scores, the means, standard deviations, differences between means were computed. Significance of difference between the mean scores of both the groups on the variable of pre-test, post-test and retention test scores were tested at 0.05 level by applying independent *t*-test.

5.2 FINDINGS

By the analysis of data, the following findings emerged. The details are as under:

1. There is no significant difference in the mean pretest scores of the students of experimental group and control group in both the experiments at $\alpha = 0.05$ with the relevance of pre-test academic achievement. Therefore the null hypothesis, 'There is no significant difference between the mean pre-test academic achievement scores of the students to be taught through problem-based instructional strategy and the students to be taught through lecture-based instructional strategy" was accepted. (Table No. 4 & 14)
2. There is no significant difference between the mean pre-test problem solving capabilities of experimental group and control group at 0.05 level. Thus the null hypothesis that, "there is no significant difference between the mean pretest problem solving capabilities scores of the students to be taught through problem-based instructional strategy and the students to be taught through lecture-based instructional strategy" was accepted. (Table 6 & 16)
3. There is a significant difference between the post-test academic achievement scores of experimental group and control group at $\alpha = 0.05$ in both the experiments. Therefore the null hypothesis that, "There is no significant difference between the post-test academic achievement scores of the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy" was rejected. (Table 8 & 18)
4. There is a significant difference between the post-test problem solving capabilities of experimental group and control group at 0.05 level. Thus the null hypothesis

that, "There is no significant difference between the post-test problem solving capabilities of the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy" was rejected. (Table 10 & 20)

5. There is a significant difference between the mean posttest retention scores of experimental group and control group at 0.05 level. Thus the null hypothesis that, "There is no significant difference between the mean posttest retention scores of the students taught through problem-based instructional strategy and the students taught through lecture-based instructional strategy" was rejected. (Table 12 & 22)

5.3 CONCLUSIONS

Keeping in view the statistical analysis of data and findings of the study, following conclusions were drawn.

1. Problem-based instructional strategy was more effective than lecture-based instructional strategy in increasing average academic achievement of 9^{th} grade male students in the subject of General Science.
2. Problem-based instructional strategy was more helpful in improving average problem solving capabilities of male students as compared with lecture-based instructional strategy.
3. Problem-based instructional strategy was more useful in facilitating increased average retention of subject matter as compared to lecture-based instructional strategy.

4. This research study testified the effects of problem-based instructional strategy on long-term memory.

5.4 RECOMMENDATIONS

In the light of findings and conclusion of the study, following recommendations were made:

1. Since the problem-based instructional strategy had significant positive effect on the academic achievement of the students so the faculty development program should be started for the preparation of teachers as a facilitator.
2. Problem-based instructional strategy is a new strategy in classroom setting; the heads of the institutions must arrange refresher courses, seminars and training programs for the teachers working at different levels to provide them with the opportunities for understanding and implementation of problem-based instructional strategy, so that the teachers may be able to teach the students through problem-based instructional strategy.
3. There is a need to transform the textbook of "General Science" in Problem-based instructional strategy instead of lecture based instructional strategy. So a committee of experts may be appointed to prepare the textbook for teaching General Science to secondary school students with problem-based instructional strategy.
4. The findings of such research studies may be published and discussed with the teachers to motivate them and help them to learn and use these instructional

strategies. Furthermore seminars and conferences may also be organized to publicize the findings of such studies.

5. Since this study was conducted on male students only, studies are needed to be planned and conducted to compare the performance of male and female students by using problem-based instructional strategy.
6. Studies may be launched with students from different cultural backgrounds such as urban and rural areas with a larger sample.
7. Further studies may be conducted to investigate the effectiveness of problem-based instructional strategy on different subjects at different levels of education.

If Problem-based Instructional Strategy is implemented on a wide basis in Pakistan, it will improve student ability to work effectively in cross and interdisciplinary teams.

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Lecture-based Instructional Strategy
Lesson Plan No. 1

Author	Muhammad Nafees
School	1. F. G Boys Secondary School Sangjani, Islamabad 2. F. G. Boys Higher Sec School Rawat, Islamabad
Subject	General Science
Grade Level	Ninth Grade
Lesson Title	**CHAPTER 2: OUR LIFE AND CHEMISTRY** **Sub topic:** Different Allotropic Forms of Carbon
Total Duration	The estimated duration of this lesson is 1 hours – 2 regular class periods (30 minute duration)

Topics	Subject Matter	BBS
General Objectives	To enable the students to: 1. Improve their scientific way of thinking 2. Enhance their intellectual abilities 3. Develop better understanding of the concepts of science 4. Inculcate the habit of observation 5. Improve their interest and curiosity about the surrounding environment and nature 6. Increase their scientific knowledge	
Specific Objectives	After learning the lesson the students will be able to: 1. Differentiate between the allotropic forms of carbon 2. Explain different types of carbon compound 3. Comprehend the properties of carbon compounds	
Teaching Aids	❖ Text book	

	❖ Chart, Flash Cards, Pictures of diamond	
Topics	**Subject Matter**	**BBS**
Knowledge of Previous Test	To make the students ready for learning the lesson, the teacher will test their previous knowledge and asks following question: 1. What are the basic building elements for life? 2. In what forms the carbon is found in the earth crust? 3. Diamond is the purest form of?	Oxygen, Carbon Carbon compounds Carbon
Announcement of Topic	After checking the previous knowledge of the students the teacher will announce the topic of the lesson and will say that dear children today I will teach you about the "Different Allotropic forms of Carbon" and will write the topic on the writing board.	Different Allotropic forms of Carbon
Teaching Method	Lecture method will be adopted during the teaching of this lesson	
Duration in hours/minutes	Ten minutes	

Presentation:

This class is a control group and will be taught in the classroom already specified for "General Science". Each formal class will follow the same pattern. Before the formal start of the lesson, the teacher will make the necessary seating arrangement so that all the students have easy eye contact with the teacher.

At the start, teacher will tell the students that the existence of an element in different physical forms due to different arrangement of atoms in space is called allotropy. These different crystalline forms are called allotropes.

The teacher will further discuss before the students that the physical properties of

allotropes are different but chemical properties are same. Carbon exists in nature in different allotropic forms; Diamond and Graphite are two main allotropes.

The teacher will also brief different types of carbon compounds and their abundance. The teacher will show some picture of allotropic forms of carbon like jewelry diamond and graphite used in lead pencils.

At the end the teacher will again brief the main points of lesson before the students.

Duration in hours/minutes	Thirty Five minutes	
Topics	**Subject Matter**	**BBS**
Recapitulation	At the end of the lesson, the teacher will test the understanding of the students and will ask the following question: 1. Differentiate between allotropic forms of carbon? 2. Explain different types of carbon compound? 3. Describe the properties of carbon compounds?	
Duration in hours/minutes	Fifteen Minutes	
Home Work	Students will be asked to define and explain different allotropic forms of carbon on their note books.	

Problem-based Instructional Strategy
Lesson Plan No. 1

Author	Muhammad Nafees
School	1. F. G Boys Secondary School Sangjani, Islamabad 2. F. G. Boys Higher Sec School Rawat, Islamabad
Subject	General Science
Grade Level	Ninth Grade
Lesson Title	**CHAPTER 2: OUR LIFE AND CHEMISTRY** **Sub topic:** Different Allotropic Forms of Carbon
Total Duration	The estimated duration of this lesson is 1 hours – 2 regular class periods (30 minute duration)

Annotation:

The existence of an element in different physical forms due to different arrangement of atoms in space is called allotropy. These different crystalline forms are called allotropes. The physical properties of allotropes are different but chemical properties are same. Carbon exists in nature in different allotropic forms; Diamond and Graphite are two main allotropes.

Concepts	❖ Differentiate between allotropic forms of carbon
Learning Objectives/ Proficiency Outcomes	Upon the completion of this lesson, students should be able to: 1. Confronting and defining problem 2. Conduct research on issues and interests by generating ideas and questions by posing problems 3. Accessing and investigating the problem 4. Synthesizing and performing the solution of the problem 5. Organize the notes and ideas for speaking 6. Participate in informal speaking activities 7. Develop and apply decision-making strategies

Technology Connections	1. The teacher will use a PowerPoint presentation to teach about Different Allotropic Forms of Carbon. 2. Students demonstrate a sound understanding of the operations of technology systems and use: o Technology to locate, evaluate and collect information from a variety of sources o Technology resources for solving problems and making informed decisions. o Technology tools to enhance learning, increase productivity and promote creativity.
Materials	Teacher and students will need the following supplies: ❖ Text Book ❖ Teacher made notes ❖ Pen, Pencil and other writing tools ❖ Overhead Projector ❖ Internet Accessible Computer ❖ Software and web resources ❖ Other Media (Video, CD Player)

Step 1	
Teacher Led Activities	Teacher will: 1. Lecture on the allotropic forms of carbon 2. Motivate students to differentiate between allotropic forms of carbon and different types of compound of carbon 3. Provide sites on website for students to use 4. Encourage students to expand their thinking to any possibilities that are logical to solve the problems
Duration in hours/minutes	Ten Minutes

Procedure:

This class is an experimental group. The students in this class will be divided into groups and each group will comprised of 5 students having two high achievers (HA), one average (AV) and two low achievers (LA). Thus there will be heterogeneous group of students with mixed abilities. They will be named as group A, B, C, D ..... and the students in these groups will be allocated roll number 1, 2, 3, 4, ... randomly. The nomenclature for the students will be like A_1, A_2, A_3, ...

Already specified "General Science" classrooms will be used for the process of teaching learning and computer lab will be used for searching out the relevant material about the topic discussed in the classroom. Each formal session follows the same pattern.

1. One of the students will be appointed to chair the proceedings and another will act as the scribe. These roles will be changed for each problem. The students will run the class session. A Facilitator, who is the member of staff and is trained in problem-based instructional strategy, will present there.
2. The first part of the class session will debrief the problem set in the previous period. The second part will be briefing for the new problem.
3. The briefing element will start with the students being given a written scenario.
4. The Chairman will read out the problem and the groups will identify the significant words and phrases it contains which need to be understood. A whiteboard or a flipchart will be provided to help the process. The groups then will turn to the issues raised in the problem. A degree of understanding will emerge, but additional goals will be identified. The groups will be setting their own learning objectives. The Facilitator will be present to ensure that the groups will remain focused and that, the correct set of learning goals has been identified. The Facilitator will be provided with a confidential document, prepared by the problem writer at the time the problem was drawn up, showing all the issues the students are expected to identify.
5. The students then leave the class session. A set of learning resources will be available to them. These will have been written, or assessed, by the problem writer as part of the problem writing process. The students will decide what resources they require, e.g. laboratory facilities, library back-up and computing access. Teachers will be available to help with their identified learning needs.

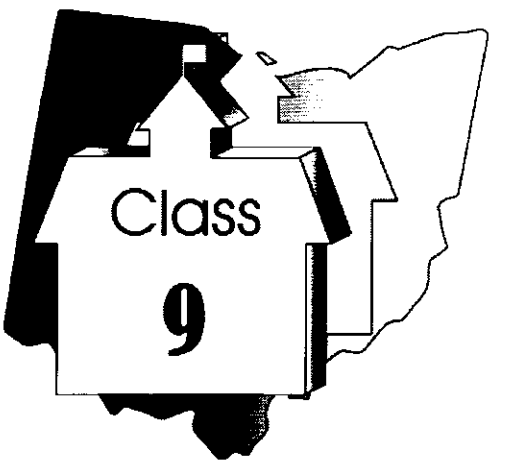
6. After the first part of the group session, the groups will present the results of their findings followed by a critique. Normally, this will be a single group activity but, on occasions, it will be an open forum with two or more groups.

Step 2	
Problem/ Scenario/ Investigation:	Arslan has a packet of lead pencils. Usually his mother used to sharp his pencil for home work. One day his mother was busy in kitchen and he had to sharp his pencil. He requested his mother to help him in sharpening the pencil. She asked him gently to do this himself. He knew that the lead in the pencil is harder than its cover but as he sharpened the pencil he observed that it sharpened very easily. **Key Problematic Areas:** **1.** **2.**
Step 3	
Student Centered Activities/Questions	Teacher will group the students for activity. One student who will chair the proceeding read the problem. The teacher will present the material that will help the students to solve the problem. Students will decide the best way to solve the problem using the resources at hand. They should note down ideas on their notepad as to how this could be done.
Duration in hours/minutes	Thirty Minutes
Step 4	
Student Assessment Strategy/Rubrics	Evaluation of the: ❖ Groups logical alternatives ❖ Presentation of alternatives ❖ Questions/answers from each group
Duration in hours/minutes	Fifteen Minutes

Achievement Tests

Student Name: _____

Schools Name: _____



General Science

Student Test Booklet

Developed by: Muhammad Nafees

DEPARTMENT OF EDUCATION
INTERNATIONAL ISLAMIC UNIVERSITY
ISLAMABAD

Directions:

Today you will be taking the **Achievement Test** of Class 9 General Science in which multiple choice questions are given.

Multiple Choice question **80 Questions** **Marks = 80**

Time = 60 Minutes

There are several important things to remember:

1. Read each question carefully.
2. Choose the most appropriate answer and shade the circle in the answer document for the test question. Mark only one choice for each question.
3. Any answers you write in the Student Test Booklet will not be scored.
4. Remember to do your own work. You are not to copy or share work with anyone.
5. Check over your work when you are finished.

Q. 1. The basic principle of science is:

(a)- Experiment (b)- Observation

(c)- Hypothesis (d)- Application

Q. 2. Silicon and germanium are:

(a)- Insulator (b)- Semiconductor

(c)- Non-transistor (d)- Non- transistor

Q. 3. The energy present in a body due to its position is called:

(a)- Elastic potential Energy (b)- Electrical Energy

(c)- Potential energy (d)- Nuclear Energy

Q. 4. Nerve cells are damaged by:

(a)- Small Pox Virus (b)- Influenza Virus

(c)- Whooping Cough Virus (d)- Polio Virus

Q. 5. In the absence of which gas it is impossible to put any fire out:

(a)- Argon (b)- Ammonia

(c)- Nitrogen (d)- Oxygen

Q. 6. The deficiency of calcium can be covered through:

(a)- Pulses (b)- Milk

(c)- Egg (d)- Fish

Q. 7. Pakistani scientists who received Nobel prize is:

(a)- Dr. Abdul Qadeer Khan (b)- Dr. Abdus Salam

(c)- Dr. Samar Mubarak Mand (d)- Dr. Munir Ahmad

Q. 8. During the process of photosynthesis in plants the energy changed into:

(a)- Thermal Energy to Electrical Energy

(b)- Thermal Energy to Light Energy

(c)- Chemical Energy to Mechanical Energy

(d)- Light Energy to Chemical Energy

Q. 9. First time hydrochloric acid was invented by:

(a)- Ibn-Haitham (b)- Bu Ali Sina

(c)- Jabir Bin Hayyan (d)- Muhammad Bin Zikraya

Q. 10. Virus is measured by:

(a)- Millimeter (b)- Micrometer

(c)- Millimicron (d)- Centimeter

Q. 11. Diodes are used to convert:

(a)- AC to DC (b)- DC to AC

(c)- Storage of charge (d)- Voltage change

Q. 12. Root, stem and leaves are not present in:

(a)- Algae (b)- Bacteria

(c)- Fungi (d)- All of them

Q. 13. Most of the current through N-type semi-conductor is due to:

(a)- Free electrons (b)- Free protons

(c)- Free neutrons (d)- Free atoms

Q. 14. It is a type of medicine that can kill the germs:

(a)- Antigen (b)- Anti body

(c)- Anti biotic (d)- Anti coagulant

Q. 15. At radio station micro waves are changed into:

(a)- Electric Waves (b)- Electric Sound

(c)- Electric signal (d)- Rhythmic Waves

Q. 16. A theory of unification of 2 basic forces is proposed by:

(a)- Dr. Abdul Qadeer (b)- Dr. Munir Ahmed

(c)- Dr. Abdul Salam (d)- Dr. Ashfaq Ahmed

Q. 17. In the period of Muslim chemistry the element discovered was:

(a)- Carbon (b)- Arsenic

(c)- Hydrogen (d)- Oxygen

Q. 18. A substance used for absorbing dangerous gases:

(a)- Bucky Ball (b)- Diamond

(c)- Graphite (d)- Charcoal

Q. 19. The age of child on which he is injected with measles is:

(a)- At birth (b)- First month

(c)- 3^{rd} months (d)- 9^{th} months

Q. 20. Sun energy changed to chemical energy in the process of:

(a)- Oxidation (b)- Reduction

(c)- Allotropy (d)- Photosynthesis

Q. 21. Two major constituent of air are:

(a)- Nitrogen and Carbon dioxide (b)- Nitrogen and Oxygen

(c)- Carbon dioxide and Oxygen (d)- Oxygen and Organ

Q. 22. The disease caused by fungus is:

(a)- Round Worm (b)- Thread Worm

(c)- Tape Worm (d)- Ring Worm

Q. 23. Type of power provides pollution free form of energy:

(a)- Thermal power (b)- Hydroelectric power

(c)- Nuclear power (d)- Solar power

Q. 24. The disease belongs to digestive system is:

(a)- Cholera (b)- Tetanus

(c)- Small pox (d)- Diphtheria

Q. 25. If we take a thing to height the energy stored in it is:

(a)- Gravitational Potential energy (b)- Chemical Energy

(c)- Potential energy (d)- Kinetic Energy

Q. 26. All the following diseases are caused by Bacteria except:

(a)- Whooping Cough (b)- Tetanus

(c)- Diphtheria (d)- Hepatitis

Q. 27. Insecticides used to kill the mosquitoes for the prevention of malaria is:

(a)- Tetracycline (b)- Streptomycin

(c)- DDT (d)- Chloroquine

Q. 28. Ascaris Lumbricoides is the scientific name of:

(a)- Round worms (b)- Ring worms

(c)- Thread worms (d)- Tape worm

Q. 29. In hydroelectric plant the energy changed into :

(a)- Potential Energy to Electrical Energy

(b)- Nuclear Energy to Electrical Energy

(c)- Thermal Energy to Electrical Energy

(d)- Chemical Energy to Electrical Energy

Q. 30. All the following methods are used to cure cancer except:

(a)- Chemo therapy (b)- Surgery

(c)- Radio therapy (d)- Hydro therapy

Q. 31. Electric signals are converted to digital signals with:

(a)- Keyboard (b)- Monitor

(c)- Scanner (d)- Modem

Q. 32. The capacity to work is called:

(a)- Power (b)- Force

(c)- Energy (d)- Heat

Q. 33. Non-crystalline form of carbon is:

(a)- Charcoal (b)- Graphite

(c)- Bucky ball (d)- Diamond

Q. 34. Source of energy not renewable is:

(a)- Solar energy (b)- Oil and gas

(c)- Nuclear fuel (d)- Wind energy

Q. 35. Islam is such a complete code of life that emphasis on:

(a)- Hydroelectric power (b)- Facts of life

(c)- Observation of life (d)- Combustion of bio gas

Q. 36. An infectious disease which spread rapidly is:

(a)- TB (b)- Whooping cough

(c)- Small Pox (d)- Pneumonia

Q. 37. Deficiency of which element cause on the face in old age:

(a)- Iron (b)- Calcium

(c)- Sodium (d)- Iodine

Q. 38. A diode is used as:

(a)- Amplifier (b)- High resister

(c)- Rectifier (d)- Modulator

Q. 39. Graphite is the non-allotropic form of carbon is:

(a)- Soft (b)- Softest

(c)- Hard (d)- Hardest

Q. 40. Diodes emitting light are used in:

(a)- Indicator bulbs (b)- Compound of Calcium

(c)- Video games (d)- Light bulb

Q. 41. Most of the diseases are caused by:

(a)- Virus (b)- Bacteria

(c)- Fungi (d)- A, B & C

Q. 42. In the period of practical chemistry the Muslims presents science as:

(a)- Observatory (b)- Ideologically

(c)- Experimentally (d)- Conceptually

Q. 43. The energy which is produced in the process of breaking the nucleus of heavy atoms:

(a)- Electrical energy (b)- Nuclear energy

(c)- Nuclear Fission (d)- Nuclear Fusion

Q. 44. In P-type semi-conductor, most of the current is due to:

(a)- Free electron (b)- Holes

(c)- Positive ions (d)- Heat

Q. 45. The compulsory component of petroleum is:

(a)- Carbon (b)- Nitrogen

(c)- Phosphorous (d)- Sodium

Q. 46. Diamond is an allotropic form of carbon, which is:

(a)- Slightly soft (b)- Softest

(c)- Slightly hard (d)- Hardest

Q. 47. The types of influenza virus are:

(a)- 5 (b)- 3

(c)- 4 (d)- 2

Q. 48. The unit of energy is:

(a)- Newton (b)- Meter

(c)- Joule (d)- Second

Q. 49. The most impure form of iron is:

(a)- Cast Iron (b)- Wrought Iron

(c)- Pig Iron (d)- Steel

Q. 50. The energy stored in the pressed spring is:

(a)- Nuclear Energy (b)- Chemical Energy

(c)- Kinetic Energy (d)- Elastic Potential Energy

Q. 51. The device that changes sound waves into electrical signals is:

(a)- Oscillator (b)- Microphone

(c)- Rectifier (d)- Loud speaker

Q. 52. The gas is responsible for fermentation is:

(a)- Oxygen (b)- Nitrogen

(c)- Carbon dioxide (d)- Chlorine

Q. 53. Element found in chlorophyll present in leaves of plants is:

(a)- Sodium (b)- Calcium

(c)- Iron (d)- Magnesium

Q. 54. All the diseases are caused by virus except:

(a)- Small pox (b)- Polio

(c)- Measles (d)- Tetanus

Q. 55. Food energy is measured in:

(a)- Ounce (b)- Degree

(c)- Gram (d)- Calorie

Q. 56. Mechanics, heat and sound belongs to the branch of science:

(a)- Geology (b)- Astronomy

(c)- Chemistry (d)- Physics

Q. 57. Neurosis is:

(a)- Physical disease (b)- Virus

(c)- Mental disease (d)- Medicine

Q. 58. Reaction in Cell or battery is:

(a)- Electrical (b)- Nuclear

(c)- Potential (d)- Chemical

Q. 59. The important element for the maintenance of agriculture is:

(a)- Sodium (b)- Potassium

(c)- Iodine (d)- Chlorine

Q. 60. The first person who prepared alcohol from fermentation was:

(a)- Muhammad bin Zikrya Razi (b)- Jabir Bin Hayyan

(c)- Al-Bairuni (d)- Ibn-ul-Haitham

Q. 61. The chemical present in the smoke of cigarette is:

(a)- Tar (b)- Nicotine

(c)- Carbon mono oxide (d)- Nitrogen dioxide

Q. 62. Ring worm is caused by:

(a)- Bacteria (b)- Virus

(c)- Amoeba (d)- Fungus

Q. 63. The range of T.V transmission from TV antenna:

(a)- 1000 KM (b)- 200 KM

(c)- 60 KM (d)- 20 KM

Q. 64. Bacteria named Mycobacterium spread disease:

(a)- Choleras (b)- Tetanus

(c)- Small Pox (d)- Typhoid

Q. 65. All the following diseases are caused by Bacteria except:

(a)- Whooping Cough (b)- Tetanus

(c)- Diphtheria (d)- Hepatitis

Q. 66. Chemical reaction of oxygen and nitrogen produces:

(a)- Nitric acid (b)- Nitrogen oxide

(c)- Nitrous Acid (d)- A, B & C

Q. 67. The simplest example of carbohydrates is:

(a)- Fructose (b)- Cellulose

(c)- Sucrose (d)- Glucose

Q. 68. The process of Fractional distillation is known by:

(a)- Ibn-Haitham (b)- Bu Ali Sina

(c)- Muhammad Bin Zikraya (d)- Jabir Bin Hayyan

Q. 69. D.P.T injection is not effective for the disease of:

(a)- Diphtheria (b)- Polio

(c)- Whooping cough (d)- Tetanus

Q. 70. Energy gained through the burning of fossil fuels:

(a)- Solar energy (b)- Tidal energy

(c)- Nuclear Energy (d)- Thermal Energy

Q. 71. All the following diseases are caused by Bacteria except:

(a)- Whooping Cough (b)- Tetanus

(c)- Diphtheria (d)- Hepatitis

Q. 72. Deficiency of iodine in human beings causes the disease:

(a)- Goiter (b)- Cancer

(c)- Tuberculosis (d)- Cholera

Q. 73. Deficiency of iron results in yellowing of plant leaves is called:

(a)- Chlorosis (b)- Photosynthesis

(c)- Anemia (d)- Osmosis

Q. 74. Diamond in its purest form is:

(a)- Blackish brown (b)- Transparent

(c)- Pink (d)- White

Q. 75. Combination of carbon, hydrogen and oxygen together makes:

(a)- Minerals (b)- Organic Compound

(c)- Inorganic Compound (d)- Carbon Compound

Q. 76. Energy due to motion is called:

(a)- Potential Energy (b)- Kinetic energy

(c)- Nuclear energy (d)- Chemical energy

Q. 77. The atmospheric nitrogen is made useful by the process of:

(a)- Nitrogen Cycle (b)- Carbon Cycle

c)- Nitrogen Fixation (d)- Water Cycle

Q. 78. Tincture Iodine is used as:

(a)- Chemical compound (b)- Antibiotics

(c)- Medicine (d)- Filling Teeth

Q. 79. Ibn-Haitham belongs to the branch of science:

(a)- Sound (b)- Heat

(c)- Vision (d)- Chemical

Q. 80. A disease which is caused only infants:

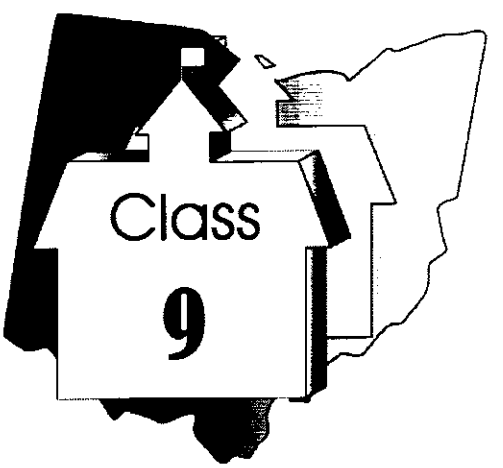
(a)- Tetanus (b)- Whooping Cough

(c)- Small pox (d)- Polio

Problem Solving Capabilities Test

Student Name:_____

School Name: _____



General Science

Student Test Booklet

Developed by: Muhammad Nafees

DEPARTMENT OF EDUCATION
INTERNATIONAL ISLAMIC UNIVERSITY
ISLAMABAD

Directions:

Today you are given a test of **Problem Solving Capabilities** of General Science class 9th. Different problems are presented to you in this. Please keep in mind following directions while giving the solution of these problems.

1. Read each problem carefully
2. Find out at least two key problematic areas in each problem/situation/scenario and also suggest solutions for each problem
3. Use only the space provided for the answer.
4. Answer in eligible handwriting.
5. Each key problematic area and solution has 1 mark.

Total Problems	**=**	**15**	**Marks =**	**60**
Total Time	**=**	**45 Minutes**		

Problem No. 1

Your region faces feminine due to lack of rain this year. As a result the domestic things of daily use are not available in the market and the people are very embarrassed. Because the city is far way from their residence, so it is not possible for everyone to go there and buy these things. The region has natural sources of water.

Key Problematic Areas: **1.**

2.

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Problem No. 2

Aftab and Kamran were two best friends. They came to city for some purpose. Their village was in a backward area far away from city. They take their lunch in the bazaar and started journey back home. In the way Kamran fell ill and started vomiting. He was exhausted. Aftab encouraged him but he remained unstable. Later he had also diarrhea too and his health started deteriorating rapidly. There was no doctor nearby. Aftab went to a house and told them about his friend's health. They also perplexed to see the condition of Kamran.

Key Problematic Areas: **1.**

2.

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Problem No. 3

Asif went to city in search of job after matriculation. He jot good job there. After some time in a cold winter night some of his friends came to see him. Asif was very happy to see them. They incinerate the gas heater, talked till late night and then went asleep. In the second period of night one of Asif's friends was out of his breath and he woke up. He did not know why it had happened. He awakened Asif. When he woke up he also was out of his breath.

Key Problematic Areas: **1.**

2.

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Problem No. 4

One day Razi went to agricultural office but he came to know that the agricultural office is on leave for a month. He was very embarrassed at this situation because he had recently planted 200 small oranges plants in this severe cold season. Their growth was good and he was very happy at this. From the last month his plants were started withering although there was not a shortage of water. He wanted to take some information from the agricultural officer to save his plants. He met you on the way.

Key Problematic Areas: **1.**

2.

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Problem No. 5

Sadia's father went to Europe last month. She is free and wanted to get admission in any foreign institution. His father said to her to send her necessary documents as early as possible. She came to city for that purpose so that she could be able so send her documents. She went to post office and asked about the sending of documents. The postman replied that these documents will take 5 to 7 days to reach there. He then went to courier office but they also replied the same. She cannot afford that because today is the last day to apply.

Key Problematic Areas: **1.**

2.

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Problem No. 6

Last week a meeting was held between teachers and parents. The main problem teachers brought in the knowledge of parents was that the children at home consume their much time in watching TV or playing video games and consequently they became lazy and tardy. Although they got balanced diet yet their growth is not satisfactory and they are not as active as they should be as a young.

Key Problematic Areas: **1.**

2.

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Problem No. 7

Shahid was a hardworking boy. Due to financial constraints he could not continue his studies and started working in a motor workshop. At start he gave his pay to his mother. Now much of the time he remained out of his home with his friends. His will power ends and he started neglecting his work, self respect, honor, dignity and indulges in theft and even murder.

Key Problematic Areas: **1.**

2.

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Problem No. 8

Mr. Aslam is a school teacher. He was very worried about the condition of his students. Most of the students of his class were remained indisposed. The school is situated in Kachi Abadi and most of the people there are ill with malaria. There is no dispensary. The attendance of the children in school is very low and due to this their study routine is disturbed a lot. Every day I think that when tomorrow all the students will come then I will teach them but the situation remains the same.

Key Problematic Areas: **1.**

2.

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Problem No. 9

As you know our country has a shortage of water and the demand of electricity is very high. Our daily routine works are greatly affected by load shedding and students suffer the most. The main source of energy production in our country is Dams which are failed to produce the required amount of electric energy.

Key Problematic Areas: **1.**

2.

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Problem No. 10

Arslan is a student of 7th class. He lives with his mother and sister. His father is an army man and they mostly remained out of the home. In this years December test he failed in the subject of Science. When his result was announced his father was at home. The parents of all the children came to school to see the result. Aslan's father was very happy to see his teacher. He asked about the progress of Arslan from his teacher. The teacher placed all the papers in front of him. His father was very disgraced to know that Arslan is very poor in his study and he is also fail in one subject. The teacher said to his father that Arslan is an intelligent boy. He is not working hard nowadays. You should do something so that he can improve his studies.

Key Problematic Areas: **1.**

2.

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Problem No. 11

In a hot summer noon Arif returned home tired. He was feeling thirst. He asked his wife to make milkshake foe him. His wife at once prepared milkshake for him. His son Asim came to give milkshake to his father. He wondered to see the drops of water on the outside surface of the jug. He asked his father that why these drops develop on the surface out side the jug.

Key Problematic Areas: **1.**

2.

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Problem No. 12

Arshad had a wrist watch. One day it stopped. He took it to his father. His father revolved the key of the watch for many times. He then returned it back to his son and said look it is working now and it will remain running for long time. Arshad surprised to see that and asked his father that why it is stopped running and now what thing is inserted in it that it started running again. His father replied that it is due to energy.

Key Problematic Areas: **1.**

2.

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Problem No. 13

Fizza returned home tired from the university. Due to intense heat she was feeling thirst. She said to her younger sister to bring a glass of cold water for her. She took water form the tape and put some ice cubes into the glass from refrigerator. When she reached to her sister with the glass of water, she said to her to put out the ice cubes from the glass so that water should not become very cold. When her sister tried to put out the ice cubes, she surprised to that there was no ice left in the glass. Fizza asked her whether she had put ice cubes into the glass or not. Her sister told her that she did put ice cubes into the glass.

Key Problematic Areas: **1.**

2.

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Problem No. 14

Shazia was dressing herself for going to school. Her sister was sitting near her playing with the pieces of paper. After adjusting her hair Shazia put the hair brush on the side table. When she had gone, her younger sister takes the brush in her hand and again started playing with the pieces of paper. She saw that the pieces of paper were sticking with the brush. He surprised to see that and asked her mother why these paper pieces are sticking with the hair brush?

Key Problematic Areas: **1.**

2.

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Problem No. 15

Aftab was preparing for his exams that light gone away. His mother lighted the candle at once and placed it near to Aftab on the table. After some time his younger sister came there and started playing with the candle. Aftab concerned that his sister might inflame her hand. He placed a transparent glass on the lighted candle. The candle extinguished after some time. Aftab was surprised at extinguishing the candle and thinks that why candle extinguished at placing the glass on it although the bulb remained lighted in side the glass.

Key Problematic Areas: **1.**

2.

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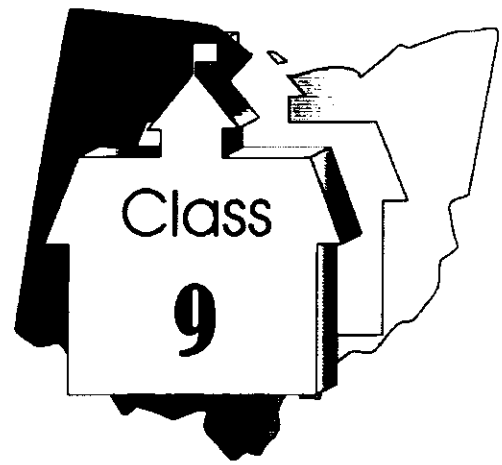
Retention Tests

Student Name: _____

Schools Name: _____



General Science

Student Test Booklet

Developed by: Muhammad Nafees

DEPARTMENT OF EDUCATION
INTERNATIONAL ISLAMIC UNIVERSITY
ISLAMABAD

Directions:

Today you will be taking the **Retention Test** of Class 9 General Science in which multiple choice questions are given.

Multiple Choice question **80 Questions** **Marks = 80**

Time = 60 Minutes

There are several important things to remember:

1. Read each question carefully.
2. Choose the most appropriate answer and shade the circle in the answer document for the test question. Mark only one choice for each question.
3. Any answers you write in the Student Test Booklet will not be scored.
4. Remember to do your own work. You are not to copy or share work with anyone.
5. Check over your work when you are finished.

Q. 1. Diamond is an allotropic form of carbon, which is:

(a)- Slightly soft (b)- Softest (c)- Slightly hard (d)- Hardest

Q. 2. Mechanics, heat and sound belongs to the branch of science:

(a)- Geology (b)- Astronomy (c)- Chemistry (d)- Physics

Q. 3. A substance used for absorbing dangerous gases:

(a)- Bucky Ball (b)- Diamond (c)- Graphite (d)- Charcoal

Q. 4. The unit of energy is:

(a)- Newton (b)- Meter (c)- Joule (d)- Second

Q. 5. Virus is measured by:

(a)- Millimeter (b)- Micrometer (c)- Millimicron (d)- Centimeter

Q. 6. It is a type of medicine that can kill the germs:

(a)- Antigen (b)- Anti body (c)- Anti biotic (d)- Anti coagulant

Q. 7. The gas is responsible for fermentation is:

(a)- Oxygen (b)- Nitrogen (c)- Carbon dioxide (d)- Chlorine

Q. 8. The types of influenza virus are:

(a)- 5 (b)- 3 (c)- 4 (d)- 2

Q. 9. The capacity to work is called:

(a)- Power (b)- Force (c)- Energy (d)- Heat

Q. 10. Deficiency of iodine in human beings causes the disease:

(a)- Goiter (b)- Cancer (c)- Tuberculosis (d)- Cholera

Q. 11. The basic principle of science is:

(a)- Experiment (b)- Observation (c)- Hypothesis (d)- Application

Q. 12. All the diseases are caused by virus except:

(a)- Small pox (b)- Polio (c)- Measles (d)- Tetanus

Q. 13. Deficiency of which element cause on the face in old age:

(a)- Iron (b)- Calcium (c)- Sodium (d)- Iodine

Q. 14. Insecticides used to kill the mosquitoes for the prevention of malaria is:

(a)- Tetracycline (b)- Streptomycin (c)- DDT (d)- Chloroquine

Q. 15. D.P.T injection is not effective for the disease of:

(a)- Diphtheria (b)- Polio (c)- Tetanus (d)- Whooping cough

Q. 16. Graphite is the non-allotropic form of carbon is:

(a)- Soft (b)- Softest (c)- Hard (d)- Hardest

Q. 17. Food energy is measured in:

(a)- Ounce (b)- Degree (c)- Gram (d)- Calorie

Q. 18. Sun energy changed to chemical energy in the process of:

(a)- Oxidation (b)- Reduction (c)- Allotropy (d)- Photosynthesis

Q. 19. Diamond in its purest form is:

(a)- Pink (b)- Transparent (c)- Blackish brown (d)- White

Q. 20. The compulsory component of petroleum is:

(a)- Carbon (b)- Nitrogen (c)- Phosphorous (d)- Sodium

Q. 21. The most impure form of iron is:

(a)- Cast Iron (b)-Wrought Iron (c)- Pig Iron (d)- Steel

Q. 22. In the absence of which gas it is impossible to put any fire out:

(a)- Argon (b)- Ammonia (c)- Nitrogen (d)- Oxygen

Q. 23. Bacteria named Mycobacterium spread disease:

(a)- Choleras (b)- Tetanus (c)- Small Pox (d)- Typhoid

Q. 24. Root, stem and leaves are not present in:

(a)- Algae (b)- Bacteria (c)- Fungi (d)- All of them

Q. 25. Non-crystalline form of carbon is:

(a)- Charcoal (b)- Graphite (c)- Bucky ball (d)- Diamond

Q. 26. Reaction in Cell or battery is:

(a)- Electrical (b)- Nuclear (c)- Potential (d)- Chemical

Q. 27. The deficiency of calcium can be covered through:

(a)- Pulses (b)- Milk (c)- Egg (d)- Fish

Q. 28. All the following diseases are caused by Bacteria except:

(a)- Hepatitis (b)- Tetanus (c)- Whooping cough (d)- Diphtheria

Q. 29. Ring worm is caused by:

(a)- Bacteria (b)- Virus (c)- Amoeba (d)- Fungus

Q. 30. Electric signals are converted to digital signals with:

(a)- Keyboard (b)- Monitor (c)- Scanner (d)- Modem

Q. 31. Silicon and germanium are:

(a)- Insulator (b)Semiconductor (c)-Non-transistor (d)- Non- transistor

Q. 32. In the period of Muslim chemistry the element discovered was:

(a)- Carbon (b)- Arsenic (c)- Hydrogen (d)- Oxygen

Q. 33. The simplest example of carbohydrates is:

(a)- Fructose (b)- Cellulose (c)- Sucrose (d)- Glucose

Q. 34. Most of the diseases are caused by:

(a)- Virus (b)- Bacteria (c)- Fungi (d)- A, B & C

Q. 35. The disease belongs to digestive system is:

(a)- Cholera (b)- Tetanus (c)- Small pox (d)- Diphtheria

Q. 36. The age of child on which he is injected with measles is:

(a)- At birth (b)- 1^{st} month (c)- 3^{rd} months (d)- 9^{th} months

Q. 37. The important element for the maintenance of agriculture is:

(a)- Sodium (b)- Potassium (c)- Iodine (d)- Chlorine

Q. 38. The range of T.V transmission from TV antenna:

(a)- 1000 KM (b)- 200 KM (c)- 60 KM (d)- 20 KM

Q. 39. Deficiency of iron results in yellowing of plant leaves is called:

(a)- Chlorosis (b)- Anemia (c)- Photosynthesis (d)- Osmosis

Q. 40. Source of energy not renewable is:

(a)- Solar energy (b)- Oil and gas

(c)- Nuclear fuel (d)- Wind energy

Q. 41. Nerve cells are damaged by:

(a)- Small Pox Virus (b)- Influenza Virus

(c)- Whooping Cough Virus (d)- Polio Virus

Q. 42. Pakistani scientists who received Nobel prize is:

(a)- Dr. Abdul Qadeer Khan (b)- Dr. Abdus Salam

(c)- Dr. Samar Mubarak Mand (d)- Dr. Munir Ahmad

Q. 43. During the process of photosynthesis in plants the energy changed into:

(a)- Thermal Energy to Electrical Energy

(b)- Thermal Energy to Light Energy

(c)- Chemical Energy to Mechanical Energy

(d)- Light Energy to Chemical Energy

Q. 44. First time hydrochloric acid was invented by:

(a)- Ibn-Haitham (b)- Bu Ali Sina

(c)- Jabir Bin Hayyan (d)- Muhammad Bin Zikraya

Q. 45. Diodes are used to convert:

(a)- AC to DC (b)- DC to AC

(c)- Storage of charge (d)- Voltage change

Q. 46. Most of the current through N-type semi-conductor is due to:

(a)- Free electrons (b)- Free protons

(c)- Free neutrons (d)- Free atoms

Q. 47. At radio station micro waves are changed into:

(a)- Electric Waves (b)- Electric Sound

(c)- Electric signal (d)- Rhythmic Waves

Q. 48. A theory of unification of 2 basic forces is proposed by:

(a)- Dr. Abdul Qadeer (b)- Dr. Munir Ahmed

(c)- Dr. Abdul Salam (d)- Dr. Ashfaq Ahmed

Q. 49. Two major constituent of air are:

(a)- Nitrogen and Carbon dioxide (b)- Nitrogen and Oxygen

(c)- Carbon dioxide and Oxygen (d)- Oxygen and Organ

Q. 50. The disease caused by fungus is:

(a)- Round Worm (b)- Thread Worm

(c)- Tape Worm (d)- Ring Worm

Q. 51. Type of power provides pollution free form of energy:

(a)- Thermal power (b)- Hydroelectric power

(c)- Nuclear power (d)- Solar power

Q. 52. If we take a thing to height the energy stored in it is:

(a)- Gravitational Potential energy (b)- Chemical Energy

(c)- Potential energy (d)- Kinetic Energy

Q. 53. All the following diseases are caused by Bacteria except:

(a)- Whooping Cough (b)- Tetanus

(c)- Diphtheria (d)- Hepatitis

Q. 54. Ascaris Lumbricoides is the scientific name of:

(a)- Round worms (b)- Ring worms

(c)- Thread worms (d)- Tape worm

Q. 55. In hydroelectric plant the energy changed into :

(a)- Potential Energy to Electrical Energy

(b)- Nuclear Energy to Electrical Energy

(c)- Thermal Energy to Electrical Energy

(d)- Chemical Energy to Electrical Energy

Q. 56. All the following methods are used to cure cancer except:

(a)- Chemo therapy (b)- Surgery

(c)- Radio therapy (d)- Hydro therapy

Q. 57. The energy present in a body due to its position is called:

(a)- Elastic potential Energy (b)- Electrical Energy

(c)- Potential energy (d)- Nuclear Energy

Q. 58. Islam is such a complete code of life that emphasis on:

(a)- Hydroelectric power (b)- Facts of life

(c)- Observation of life (d)- Combustion of bio gas

Q. 59. An infectious disease which spread rapidly is:

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(c)- Kinetic Energy (d)- Elastic Potential Energy

Q. 66. The device that changes sound waves into electrical signals is:

(a)- Oscillator (b)- Microphone

(c)- Rectifier (d)- Loud speaker

Q. 67. Neurosis is:

(a)- Physical disease (b)- Virus

(c)- Mental disease (d)- Medicine

Q. 68. The first person who prepared alcohol from fermentation was:

(a)- Muhammad bin Zikrya Razi (b)- Jabir Bin Hayyan

(c)- Al-Bairuni (d)- Ibn-ul-Haitham

Q. 69. The chemical present in the smoke of cigarette is:

(a)- Tar (b)- Nicotine

(c)- Carbon mono oxide (d)- Nitrogen dioxide

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STATISTICAL DATA (TEST SCORES)

Pre-Test and Post-test scores of Academic Achievement, Problem Solving Capabilities and Retention test in FGBHSS, Rawat

CONTROL GROUP						EXPERIMENTAL GROUP				
S. NO.	Ach Pre-test	Ach Post-test	PSC Pre-test	PSC Post-test	Ret Test	Ach Pre-test	Ach Post-test	PSC Pre-test	PSC Post-test	Ret Test
1.	42	56	24	23	40	42	67	23	40	66
2.	40	54	22	23	38	40	65	22	39	65
3.	39	53	20	22	37	39	65	21	38	64
4.	38	54	19	17	37	38	64	19	36	61
5.	37	52	17	17	36	37	63	18	33	60
6.	36	50	16	15	37	35	61	17	31	60
7.	35	51	15	16	36	34	62	16	30	60
8.	34	50	14	16	35	34	61	16	30	59
9.	34	51	14	15	35	34	61	15	28	59
10.	34	49	11	13	33	34	60	13	27	58
11.	33	48	11	13	34	33	60	12	25	58
12.	33	47	11	12	32	33	59	11	24	58
13.	32	48	10	11	31	32	59	10	23	57
14.	31	47	10	9	32	31	58	10	22	57
15.	31	48	9	11	30	30	58	9	23	56
16.	30	47	9	10	29	30	57	9	23	58
17.	30	46	9	9	30	30	57	8	23	56
18.	30	45	9	9	29	29	57	8	22	55
19.	29	46	9	8	28	29	56	7	22	57
20.	29	44	8	9	27	29	55	7	22	55
21.	28	45	8	8	28	28	55	6	21	55
22.	28	43	8	7	27	28	54	6	20	54
23.	27	44	7	8	28	27	52	6	19	50
24.	27	43	6	8	26	26	52	5	20	50
25.	26	42	6	7	25	26	51	4	20	48
26.	26	43	5	6	26	26	51	4	19	47
27.	26	42	5	5	24	25	50	3	19	48
28	25	41	5	4	24	25	50	3	19	47
29.	25	42	2	4	23	24	49	2	18	48
30	25	39	2	4	23	24	48	2	17	47
31.	24	38	2	3	22	23	48	2	16	46

32.	24	37	2	3	22	22	47	1	15	46
33.	22	37	1	2	21	21	46	1	14	45
34.	22	35	0	2	21	--	--	--	--	--

Pre-Test and Post-test scores of Academic Achievement, Problem Solving Capabilities and Retention test in FGBHS, Sangjani

	CONTROL GROUP					EXPERIMENTAL GROUP				
S. NO.	**Ach Pre-test**	**Ach Post-test**	**PSC Pre-test**	**PSC Post-test**	**Ret Test**	**Ach Pre-test**	**Ach Post-test**	**PSC Pre-test**	**PSC Post-test**	**Ret Test**
1.	44	56	23	25	42	46	68	24	40	66
2.	43	54	19	22	40	44	69	20	39	65
3.	42	55	17	19	41	43	65	17	37	64
4.	41	52	16	17	38	41	63	17	35	60
5.	40	51	16	16	39	40	60	16	32	58
6.	36	49	16	15	35	40	61	16	30	56
7.	36	48	13	13	37	36	58	15	28	57
8.	35	46	12	14	36	36	59	14	28	55
9.	35	45	12	13	34	35	56	14	27	56
10.	33	46	11	12	31	33	57	13	26	56
11.	32	44	10	13	33	33	55	12	27	52
12.	31	45	7	10	30	32	53	9	22	52
13.	30	43	7	9	29	31	54	8	22	51
14.	30	42	7	9	27	30	51	7	21	50
15.	29	44	7	8	28	30	49	6	21	48
16.	28	41	5	7	26	29	48	5	20	47
17.	28	43	4	7	27	28	47	5	20	46
18.	27	40	4	6	25	28	45	4	19	42
19.	27	38	3	6	26	27	44	4	18	43
20.	22	36	2	5	25	25	46	4	17	44
21.	--	--	--	--	28	22	45	2	16	41

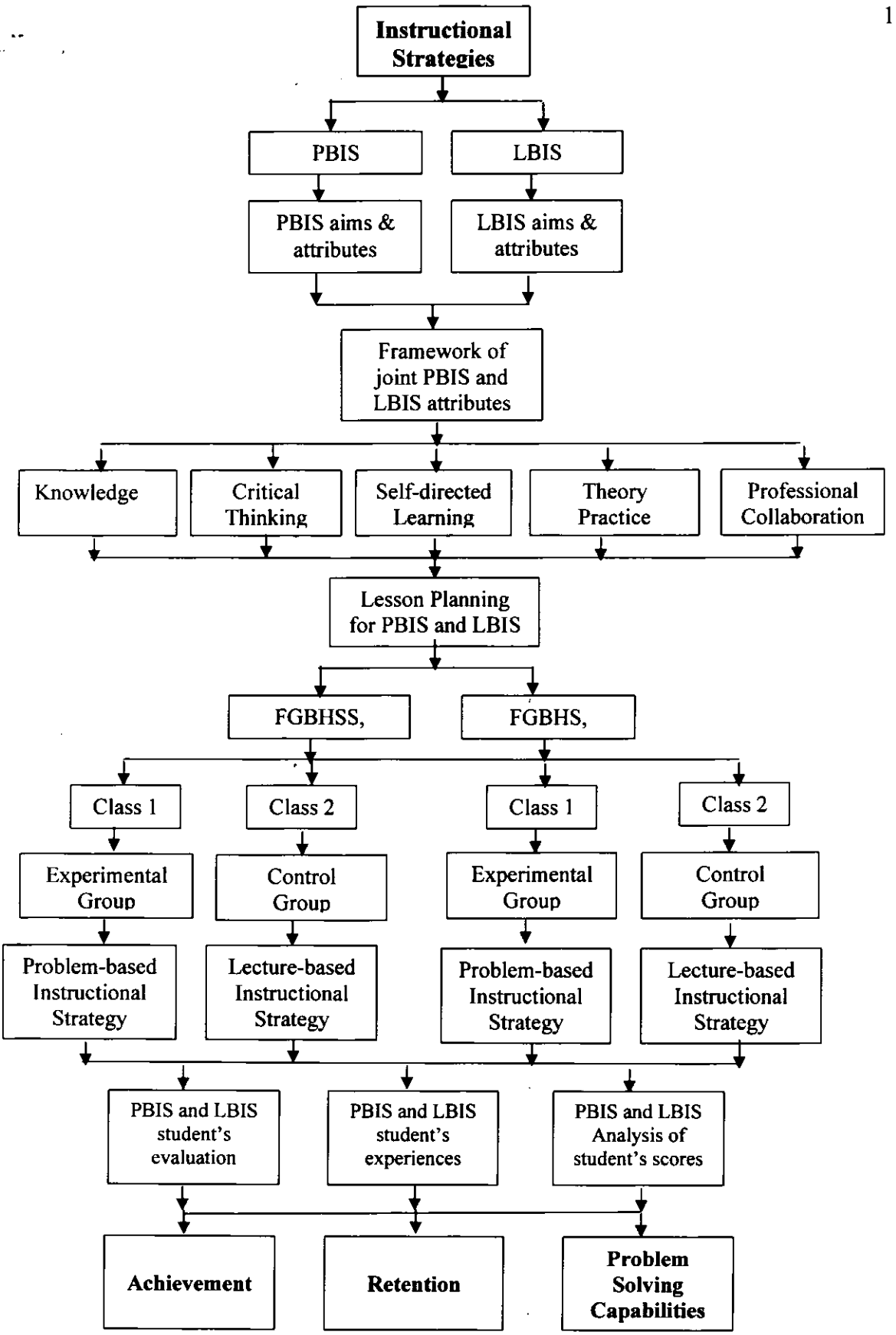

Figure: Conceptual Framework of Implementing Instructional Strategies