A COMPARATIVE STUDY OF AUSUBELIAN AND TRADITIONAL METHODS OF TEACHING PHYSICS AT SECONDARY SCHOOL LEVEL IN PAKISTAN

By

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NATIONAL UNIVERSITY OF MODERN LANGUAGES
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Candidate of PhD-Education at the National University of Modern Languages do hereby declare that the thesis (Title) “A Comparative Study of Ausubelian and Traditional Methods of Teaching Physics at Secondary School Level in Pakistan”.

Submitted by me in partial fulfillment of PhD degree, is my original work, and has not been submitted or published earlier. I also solemnly declare that it shall not, in future, be submitted by me for obtaining any other degree from this or any other university or institution.

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ABSTRACT

**Thesis Title**: “A Comparative Study of Ausubelian and Traditional Methods of Teaching Physics at Secondary School Level in Pakistan”.

The work reported here is an investigation about the effectiveness of two teaching methods (i.e. Ausubel teaching method and traditional teaching method) in the teaching of physics at secondary level in Pakistan. The main objectives of this study were to compare the relative effectiveness of these teaching methods on students’ achievement and attitude, and to find out the impact of pre-lab on the learning of the students. This experimental work was carried out for the period of thirty-five weeks in the physics classroom and laboratory of Govt. Comprehensive School, Jhelum (Pakistan). Sixty-two secondary school science students of class X were randomly selected for this experiment. The posttest-only equivalent group design was used for this study. It involved two groups; experimental and control. These groups were equated on the basis of marks achieved by the students in a test of 8th class science. The different tools used to collect the data were; the Achievement tests, Post labs, and Attitude scale. Experimental group was taught through Ausubel’s teaching method while control group was taught through Traditional.

To measure the achievement of the students in the science theory and practical, the researcher administered the following tools; Experimenter’s tools 1 & 2, and post-labs. The other achievement tests used in the study were the Term Tests 1 & 2 administered by the school, and the question paper of physics theory and practical constructed, administered and evaluated by the Board of Intermediate and Secondary Education Rawalpindi (SSC annual examination 2005). To measure the scientific attitude of the students, an instrument was constructed and validated and then administered to the whole sample. Data collected by tools were analyzed by the application of software, SPSS and presented in the form of mean scores. To compare the mean scores of experimental and control groups, t-test was employed.

The study indicated that Ausubel’s teaching method was found more effective than traditional teaching method in improving the achievement of the students in the subject of physics as measured by experimenter’s tools, term tests and in the SSC examination,
2005. The study also showed that the use of pre-labs significantly improved the performance of the students. It has found in various significant indications that the new way of teaching has improved performance of the students in various tests and some evidence that attitude have changed.

The nature of pre-lab and post-lab need more improvement and further investigation at other levels and regions. There relative effectiveness should be evaluated so that the more effective tool can be used in the future. The persistence increase in the standard deviations for the experimental group suggests that not all students benefited equally. This gives rise to another area ‘cognitive learning styles’ that should be explored. This study can be seen as an exploratory study and offers encouragements that the new approach has considerable value for the learners. It needs replication, using many teachers, with boys and girls, and in all disciplines of science.

Muhammad Safdar
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Muhammad Safdar
DEDICATION

In the
Memory of
My Mother & Grand Mother
LIST OF ABBREVIATIONS

ATM  Ausubelian Teaching Method
BISE  Board of Intermediate and Secondary Education
IBE  Institute of Business Education
NUML  National University of Modern Languages
SPSS  Statistical Package for Social Sciences
SSC  Secondary School Certificate
STS  Science Technology and Society
TTM  Traditional Teaching Method
CHAPTER 1

INTRODUCTION

1.1 Background of the Problem

Education is the process through which societies plan their socio-economic development. It is the most cogent instrument in the progress of any nation; hence the quality of education has to be improved for faster, wholesome development of the learners. It is universally acknowledged that any attempt at the improvement in the quality of education ultimately depends on the quality of teaching and learning in the classrooms and laboratories.

Science education is core area of our education system and science is an essential and fundamental subject in our curriculum. Science education provides us an opportunity to think critically, and unify the concepts of man’s natural environment and utilize it in the benefit of mankind. It can be very productive if we utilize our abilities to take benefit from it.

Ebenezer and Connor (1998), state that science educators refer to teaching Science, Technology and Society connections as “authentic science” – interdisciplinary science education that can be made relevant and accessible to all school children. Science, Technology and Society (STS) education places science in a larger social context—an environmental, economical, political, cultural, and historical context.

Science education research shows that teaching STS issues enables students to identify a problem, analyze data, make rational choices among alternatives, and take appropriate actions and is necessary for citizens to be considered scientifically literate (Aikenhead, 1980; Zoller, 1987).
In science education we are teaching students to use one form of knowing that is the experimental. Holmes (1977), states that science education includes general aims and objectives, teaching strategies, curriculum theories and philosophy of science as it’s specifically, educational features.

At secondary level, science education provides the students with opportunities to think critically, practice different teaching methods and develop scientific concepts, which facilitate the understanding of the physical environment. Science also develops attitude, which is useful in a sense that it gives people a simplified and practical guide for appropriate behaviour. Positive attitude towards learning, subject area, and teaching method are all-important because they affect student’s motivation to learn, and continuing motivation not only to apply and utilize what has been learnt, but also to seek out further related opportunities.

Effective classroom teaching in science requires advance thinking and proper planning. Certain points like objectives, content, methods, teaching aids, evaluation techniques are required to be attended to properly in advance for achieving desired outcomes. According to the World Book Encyclopedia (1970) the teaching is a process by which one person helps other to achieve knowledge, skills and attitudes. A good teacher provides guidance for the learner. The guidance encourages the learner to do things that result in desired learning. Hence, it is said that teaching creates conditions, which encourage and stimulate learning.

Modern life depends on the teaching-learning skills and attitudes developed among students in the educational institutions. In schools, teachers have great influence on children by encouraging interest, by developing talent, and by providing useful factual, conceptual, procedural and meta-cognitive knowledge about the world (Arends, 2004).

Many teaching methods have their importance in the field of teaching. Numerous curriculum writers, psychologists, educationists take up the need for variety of teaching
methods and suggest that three arguments support this position: (1) not all students learn equally well when the same teaching methods are applied, (2) certain teaching methods are more applicable to particular situation, and (3) not a single method is superior particularly in terms of students’ performance.

Arends (2004), states that the task of teaching the young is simply too important and complex to be handled entirely by parents or through the informal structures of earlier eras. Modern society needs schools staffed with expert teachers highly skillful in methodology to provide instruction. As expert and professional, they are expected to use best practice to help students learn essential knowledge, skills and attitudes.

Some teaching methods are very old. Socrates (the Greek philosopher) used his own teaching method of question–answer. In ancient India, teachers developed their own teaching method/teaching models to produce desirable changes in the behaviour of the learner. According to Chohan (1989), a teaching method enables the students to interact in such a way that specific changes occur in their behaviour. He says, “A teaching method describes the process of specifying and producing particular environmental situation.” The concept of teaching method is meaningful for teaching because it helps to overcome the obstacles facing the teacher and the learner. In the view of Arends (2004), “A teaching method is a plan, or pattern, for helping students to learn specific kinds of knowledge, attitudes, or skills. It encompasses specific teaching steps design to accomplish desired educational outcomes.”

Teaching methods may be classified as: (a) *Traditional* (lecture/presentation, direct instruction, programmed instruction, memorization / rote learning), (2) *Expository* (Ausubelian teaching method), (3) *Enabling* (simulation games, brainstorming, sociodrama, inquiry). Sing (2004), expresses that traditional methods are content centered, teacher remains more active, more cognitive and less affective. In the view of Rao (2001), traditional methods are concerned with the recall of factual knowledge and largely ignore higher levels of cognitive outcomes.
In Pakistan, much teaching (which can be described as traditional) is based on teacher-centered, lecture presentation and the students memorize the teachers’ words by heart. Credit is given of the correct recall of as much as possible in formal tests and examinations. This approach does not occur in all countries and education systems but is a particular feature of much Pakistani education and in many other countries.

The great emphasis of Ausubel et al. (1968) was in their clear way of distinguishing from rote memorization from what they call meaningful learning. In addition, they separated these very clearly from the reception-discovery learning axis. The figure given below gives clearer picture which is derived from the Ausubel et al (1968).

Figure 1.1  Reception-discovery and meaningful-rote learning axis

There are numerous ways by which school-learning can be characterized, for example:

(a) Teacher-centered: student-centered.
(b) Reception: discovery
(c) Individual learning: group learning
(d) Conceptual learning: skills learning
Children’s minds are not blank slates to receive instruction in a natural way. They approach learning experiences presented with previously acquired notions and these notions influence what is learnt from new experiences in a number of ways. In the view of Sabir (1992), children form ideas and interpretation as a result of everyday experiences in all respects of their lives; through practical activities, talking with other people around them and through the media. Individuals internalize their experiences in a way which is at least partially their own; they construct their own meaning.

Right from birth, the child develops beliefs about the things that happen in its surroundings. Initially, these beliefs and concepts are isolated and independent of one another. But when the child grows, all his experiences stimulate the development of more generalized sets of expectations. According to cognitive psychologists, teaching and learning in the classroom depends on what the students have already in their minds’, as well as on the learning context in which they find themselves.

Most of the researches on students learning science suggest that students bring their own conceptions of science to explaining the natural world (Driver 1983, Osborne 1986).

In the view of Johnson (1979), the information processing view divides learning into three phases: (i) attending to new information (ii) acquiring and retaining information, and (iii) retrieving information from memory and transferring it to new situation. The way that information is processed in learning has been summarized in the model presented by Johnstone, A.H. (1993). It represents the flow of the information through the memory system and the processing of such information. Such a model makes predictions about how input information is dealt within the human mind so that meaningful learning can take place. It also indicates where mislearning may take place.
Figure 1.2 Information Processing Model of Johnstone

In the above figure, the learner is seen to view new events, observations and instructions through a perception filter, which is influenced by what is already stored in the long-term memory. Thus, the learner selects and interprets new information in terms of what he/she already knows. The diagram 1.2 also represents that previous knowledge affects new knowledge. It includes the ideas of Ausubel. Ausubel (1968) argues that: “the most important single factor influencing learning is what the learner already knows.”

Gupta (1995) quotes Ausubel, “meaningful learning takes place when new knowledge is linked to what a student already knows.” According to Ricardo (1990), “in the process of ‘meaningful learning’, the new knowledge interacts with existing concepts and is assimilated, altering the form of both the anchoring concepts and the new assimilated knowledge.” Hence, before planning classroom instruction, it is important to identify in advance ways to relate new knowledge to some broad concept or generalization already familiar to a student. This gives rise to the term advance organizer. Gupta (1995), describes that advance organizers can assume many forms: (a) structure of a discipline (can be used to relate parts to the whole) (b) a question (c) a diagram. Ausuble believes that information /scientific concept is learned more easily if it is
organized and sequenced logically. Ausubel’s theory (some time called expository teaching/deductive teaching) consists of three principles: (1) Concepts are meaningful only when the student can visualize them and subsume them within a cognitive structure. (2) Always proceed from the most generic concepts to the most specific one. (3) Students’ readiness; which include their current knowledge, stage of cognitive development, and predominant mode of intellectual functioning.

Science is a system of knowledge, a process of acquiring and refining knowledge through the processes of observation and experimentation. Science has three major elements (a) Processes (b) products (c) human attitude. The major contribution of science lies in the inculcation of scientific attitude among its learners through its study. Kumar (1995), includes the various aspects in the scientific attitude; (i) Making pupils open minded (ii) Helping pupils to make critical observation (iii) Developing intellectual honesty among students (iv) Developing curiosity among pupils (v) Developing unbiased and impartial thinking. So, we say that scientific attitude means; “Open mindedness”, a desire for accurate knowledge, and confidence in procedures for seeking knowledge.

In the opinion of Kumar (1995), scientific attitude may be developed either by direct teaching in the classroom/laboratory or by out of school experiences gained by the pupils. He further writes the ways for developing scientific attitude among the pupils; (i) Making use of planned exercises, (ii) proper use of practical periods, (iii) atmosphere of the class, (iv) co-curricular activities in science, (v) personal example of the teacher. In science education, we are teaching students to use theoretical knowledge i.e. experimental. But without any strong theoretical background related to the experiment, it is too much difficult for the students to understand what is happening in the lab. Pre-lab provides the science students to reflect on what has happened, and to check up on any aspect of information that they are unsure about.

Bond, et al. (1986) describe that pre-lab activity are carried out prior to the scheduled laboratory period to achieve the instructional objectives to the optimal. He
further goes on to say that post-lab activities enhance students learning and various skills of calculation, communication and application.

Ausubelian teaching method of meaningful learning has been developed in different subjects at different levels. This has been compared with Traditional methods in terms of achievement of students. Ausubelian teaching method was found to be significantly superior to traditional method by Ausubel (1960), Anderson (1973), Alexander (1977), Schwartz (1979), Richardson (1986), Lewis (1987) and Siddiqui (1993) etc.

On the other hand advance organizer model (Ausubelian teaching method) and traditional methods were found to be equally effective by Barren (1971), Moore (1973), Goodman (1977), Salman (1977), Carnes (1985).

Traditional teaching methods have been found superior to Ausubel’s advance organizer model by a few investigators in terms of achievement like Tennyson (1986).

From the foregoing presentation of the studies, it may be seen that these studies have come up with contradictory results. It indicated that this area did not receive proper attention in Pakistan; however, Hussain, (2004) compared the traditional and super learning techniques for teaching science at elementary level. Ishtiaq (2005) studied teaching English through direct and traditional methods at secondary level.

In Pakistan, some efforts are being made to train the science teachers at elementary and secondary level to improve the teaching-learning process in the classrooms and laboratories. The Federal and Provincial Education departments have conducted a series of teacher training programs in the years 2003, 2004, 2006, for this purpose. Science education projects (SEP I, SEP II) are the examples of the on going teacher training programs. In this context, the researcher felt that these teaching methods should be experimented in Pakistani conditions (i.e. in science classrooms and
laboratories) before they are accepted as a system of teacher education in this country. Present study leads to satisfy this need to some extent.

1.2 **Statement of the Problems**

Science is the need of all times, so its teaching and learning have a great significance in an educational setup. Keeping in view the dictum, “how to teach is more important than what to teach”, an effort was made to compare the effects of teaching of physics on students’ achievement and attitude, taught through Ausubelian and traditional teaching methods at secondary school level in Pakistan.

1.3 **Significance of the Study**

Pakistan is a developing country and is facing a lot of problems in many educational areas. It is the need of the hour to obtain maximum benefits from our scientific educational programme. In order to achieve the objectives, related to science, presented in the National Education Policy, IQRA (1998-2010), we need improvement in the field of curriculum development, system of evaluation and also in the field of science education (i.e. theory and practice).

- In the view of Joyce and Weil (1992), we need to design suitable teaching strategy/strategies for the wholesome development of our students. There still exists a big gap between theoretical knowledge and actual teaching in the classroom and laboratories. New teaching methods need to be incorporated in our teaching practices. Varieties of teaching methods have been evolved to design instruction. But which teaching method is most appropriate, having better impact can only be answered through research. Therefore, this research was needed.

- Teaching is scientifically controlled and goal oriented activity. Hence, this study will help the science teachers to improve their instructional effectiveness in an interactive atmosphere.
• Bond et al. (1986), state that expecting students to engage in laboratory activities without some form of prior consideration may leave them feeling insecure and result in a rather poor understanding of what is happening. It is therefore useful to provide some information and activities in advance by highlighting the essential ideas of the practical work. Hence, the pre-lab will help the students to improve their understanding about their practical work as well as to validate their theoretical knowledge.

• This study is likely to enable the teacher to foster in the students the habits of preparation before coming in to the laboratory. Therefore, this study will be helpful in improving the standard of teaching and learning science in the laboratory.

• The findings of this study may help the teacher trainers, human resource managers to improve the efficiency of their pre-service and in-service teachers so they may be able to improve their instructional strategies in the physical science classrooms and laboratories.

• The users of this study will be the science teachers, curriculum developers, Secondary Educational Boards, Science Foundations and Text Book Boards.

• This experimental research will serve as an instrument and model for the people related to the field of science education.

• This study may be helpful to conduct further researches to compare the effectiveness of different teaching methods at different levels in different subjects.
1.4 Objectives of the Study

This study intended:

1. To compare the effects of Ausubelian and Traditional Teaching methods (i.e. meaningful learning vs. rote learning) on students’ achievement in the subject of physics.
2. To find out the effects of pre-lab on the learning of the students in the physical science laboratory.
3. To compare the scientific attitude as developed by Ausubelian and Traditional Teaching Methods among the secondary school science students.
4. To correlate the attitude scale scores and the achievement scores of the sample students.
5. To develop the concept maps of all the units of the text-book of physics for secondary class, published by Punjab Text Book Board Lahore.

1.5 Delimitation of the Study

The following delimitations were made for this study:

- “Teaching methods” is too vast and complex field. There are number of teaching methods presently available. It is neither feasible nor desirable to take more than two teaching methods in one research study. Therefore, the present study is restricted to a comparative study of two teaching methods, namely, Ausubelian teaching method (ATM) and Traditional teaching method (TTM).

- Sample was taken from a single school due to feasibility of treatment, controlling the school environment, timetable, economy of time of experimentation and the like. The sample of the study consisted of two groups of secondary school science students of Government Comprehensive High School, Jhelum (a typical mixture of the students’ population). Each group consisted of 31 students. Therefore, the present study was confined to 62 secondary school science students.
• The study was confined to the subject of Physics for secondary classes, as it is a typical fundamental science.

• The selection of the dependent variables has been limited to achievement and scientific attitude, because these are possibly the two most important outcomes.

• All the subjects for the treatment were male students.

1.6 Hypotheses of the Study

H₀₁. There is no significant difference between the achievement scores of students in the subject of Physics (Theory) taught through Ausubelian and Traditional teaching method as measured by experimenter’s tools ‘1’.

H₀₂. There is no significant difference between the achievement scores of the students in the subject of Physics (Practical) taught through Ausubelian and Traditional teaching method as measured by experimenter’s tool ‘1’.

H₀₃. There is no significant difference between the achievement scores of the students in the subject of Physics (Theory + Practical) taught through Ausubelian and Traditional teaching method as measured by experimenter’s tool ‘1’.

H₀₄. There is no significant difference between the achievement scores of students in the subject of Physics (Theory) taught through Ausubelian and Traditional teaching method as measured by experimenter’s tools ‘2’.

H₀₅. There is no significant difference between the achievement scores of the students in the subject of Physics (Practical) taught through Ausubelian and Traditional teaching method as measured by experimenter’s tool ‘2’.
$H_{06}$. There is no significant difference between the achievement scores of the students in the subject of Physics (Theory + Practical) taught through Ausubelian and Traditional teaching method as measured by experimenter’s tool ‘2’.

$H_{07}$. There is no significant difference between the total achievement scores of the students in the subject of Physics (Theory) taught through Ausubelian and Traditional teaching method as measured by experimenter’s tool ‘1 and 2’.

$H_{08}$. There is no significant difference between the total achievement scores of the students in the subject of Physics (Practical) taught through Ausubelian and Traditional teaching method as measured by experimenter’s tool ‘1 and 2’.

$H_{09}$. There is no significant difference between the total achievement scores of the students in the subject of Physics (Theory + Practical) taught through Ausubelian and Traditional teaching method as measured by experimenter’s tool ‘1 and 2’.

$H_{010}$. There is no significant difference between the achievement scores of students in the subject of Physics (Theory) taught through Ausubelian and Traditional teaching method as measured by ‘First Term Test’.

$H_{011}$. There is no significant difference between the achievement scores of students in the subject of Physics (Practical) taught through Ausubelian and Traditional teaching method as measured by ‘First Term Test’.

$H_{012}$. There is no significant difference between the achievement scores of students in the subject of Physics (Theory + Practical) taught through Ausubelian and Traditional teaching method as measured by ‘First Term Test’.

$H_{013}$. There is no significant difference between the achievement scores of students in the subject of Physics (Theory) taught through Ausubelian and Traditional teaching method as measured by ‘Second Term Test’. 
H_{014}. There is no significant difference between the achievement scores of students in the subject of Physics (Practical) taught through Ausubelian and Traditional teaching method as measured by ‘Second Term Test’.

H_{015}. There is no significant difference between the achievement scores of students in the subject of Physics (Theory + Practical) taught through Ausubelian and Traditional teaching method as measured by ‘Second Term Test’.

H_{016}. There is no significant difference between the total achievement scores of the students in the subject of Physics (Theory) taught through Ausubelian and Traditional teaching method as measured by First and Second Term Test.

H_{017}. There is no significant difference between the total achievement scores of the students in the subject of Physics (Practical) taught through Ausubelian and Traditional teaching method as measured by First and Second Term Test.

H_{018}. There is no significant difference between the total achievement scores of the students in the subject of Physics (Theory + Practical) taught through Ausubelian and Traditional teaching method as measured by First and Second Term Test.

H_{019}. There is no significant difference between the achievement scores of the students in the subject of physics (theory and practical) by the use of Ausubelian and Traditional teaching method in the secondary school certificate (SSC) examination conducted by the Board of Intermediate and Secondary Education Rawalpindi (Annual 2005).

H_{020}. There is no significant difference between the achievement scores of the students in the subject of physics theory as measure by the use of Ausubelian and Traditional teaching method in the SSC examination conducted by the BISE Rawalpindi (Annual 2005).
There is no significant difference between the achievement scores of the students in the subject of physics practical as measured by the use of Ausubelian and Traditional teaching method in the SSC examination conducted by the BISE Rawalpindi (Annual 2005).

There is no significant difference between the achievement of the students with pre-lab and students without pre-lab in the post labs results.

There is no significant difference between the scores achieved by the experimental and control groups in the attitude scale.

There is no relationship between the marks achieved by the students in the Secondary School Certificate Examination 2005 conducted by the Educational Board and the attitude scale scores of the experimental and control groups.

1.7 Procedure of the Study

In order to draw any valid conclusion from an experimental research, the measuring instruments should be reliable and valid. This requirement is usually met by employing standardized instruments. Since no research has been done in the area selected for the research, therefore the researcher constructed self-made instrument for the purpose. The present study required the following tools and measures.

(1) A test from 8th class science for equating the two groups (experimental and control),
(2) Two tests in the subject of physics for measuring achievement,
(3) Pre-labs and Post-labs,
(4) Concept maps,
(5) Instrument to measure the scientific attitude of the sample students,
(6) Term tests, developed and administered by the school, and
(7) Achievement test of physics for secondary class developed by BISE, Rawalpindi.
The study was undertaken to compare the differential effects of science teaching through Ausubelian and traditional teaching methods on students’ achievement and attitude, and also to find out the effects of pre-lab on the learning of the students. The research work was carried out for 35 weeks in the physical science classroom and laboratory of Government Comprehensive High School, Jhelum.

1.7.1 Tools of the Research Study (Construction, Improvement, Validation, Finalization)

A. Experimenter’s Tools

1. ACHIEVEMENT TEST FROM 8TH CLASS SCIENCE

A test from 8th class science was constructed, tried out, improved and administered to the whole sample of 62 science students. The marks achieved by the students were arranged in descending order and were used to equate the two groups i.e. experimental & control. At the beginning of the experiment, each group contained thirty-one students but during the experimental period, one subject (student) of the control group became dead and could not complete the requirements of the experiment. Therefore, 31 students of experimental and 30 of the control group completed the whole experimental period.

2. TWO ACHIEVEMENT TESTS IN THE SUBJECT OF PHYSICS FOR SECONDARY SCHOOL SCIENCE STUDENTS

Keeping in view the content of the study and the Blooms Taxonomy of Educational objectives, two achievement tests (i.e. Physics Part I and Physics Part II) of 100 marks (theory 75 marks & practical 25) were developed by the researcher. Test construction was made in four phases: (1) Planning Phase (2) Preparation Phase (3) Try-out Phase, and (4) Administration/evaluation Phase.
3. **PRE-LAB**

Ausubel (1968), stated that “if I had to reduce all of the educational psychology to just one principle, I would say, ‘the important single factor influencing learning is what the learner already knows’”. Keeping in view the above-cited statement, the pre-labs for each experiment were prepared by highlighting the essential ideas related to the work to be done. Pre-lab is what the learner already knows and its effect on learning. It helps students to learn about their knowledge construction which links pre-lab knowledge to post-lab.

4. **POST-LAB**

A small but comprehensive post-lab was introduced at the end of each experiment. The purpose of introducing this post-lab was: (1) to relate the pre-lab knowledge to the post-lab knowledge,(2) to relate the theory with the practical work (i.e. to verify laws, principles.), and, (3) to find the effects of pre-lab on the learning of the students. Post-lab problems were chosen from the physics Text Book for secondary classes, from practical syllabus, and from every day life. All the above developed a better understanding of the subject (experiment).

5. **INSTRUMENT TO MEASURE THE SCIENTIFIC ATTITUDE OF THE STUDENTS**

After defining the construct, that is, “scientific attitude”, it was broken down into the seven subscales / domains / indicators (curiosity, open-mindedness, rationality, courage, objectivity, aversion to superstition, and suspended judgments). Eight statements, four positive (favourable) and four negative (unfavourable) for each indicator were constructed. The instrument was administered to the sample of 200 students and scored by applying Likert scale. For favourable statements, strongly agree response was given a weigh of 5, agree response a weigh of 4, undecided response a weigh of 3, disagree response a weigh of 2, and strongly disagree response a weigh of 1. For
unfavourable statements, the scoring system was reversed. For each student the researcher obtained a total score by summating the scores for the individual item.

6. CONCEPT MAPS

The concept map is an instructional tool that has been devised on the basis of Ausubel’s learning theory. According to Novak and Gowin (1984), “concept maps serve to clarify links between new and old knowledge and force the learner to externalize those links.” To represent meaningful relationships between concepts, the researcher identified the key concepts in the chapter, ranked them, and prepared a network of concepts (concept map) of each unit (by arranging concepts logically) to make the content meaningful to students. The mega concept (general concept) was placed at the top and included less general concepts, and then more specific, to make the concepts progressively differentiated by their level of specificity. The concept maps for each chapter (Unit) are shown in chapter 4.

6. LESSON PLANS (AUSUBELIAN TEACHING METHOD AND TRADITIONAL TEACHING METHOD)

Each lesson plan was prepared by the researcher and by the science teacher on each mega concept presented in the concept maps of all the units presented in chapter 4. Model lesson plans for both teaching methods (ATM & TTM) are shown in chapter- 3.

B. Term Tests

Two ready made tests of 100 marks (theory 75 marks & practical 25) were administered to the whole sample at the end of December 2004 and February 2005. The written tests and practical examinations were conducted under the supervision of the controller of examination of school. These tests were administered to the whole sample along with the other students, and evaluated by the science teachers of the school. After the compilation of the result, the marks achieved by the sample were then obtained from the controller of examination and saved for further statistical procedure.
C. Question Paper Of Physics Theory of 75 Marks And Practical of 25 Marks Constructed, Administered and Evaluated by The Board of Intermediate and Secondary Education Rawalpindi (SSC Annual Examination 2005).

The marks achieved by the sample (physics theory and practical) in the experimenter’s tools and in the school examination were then verified by the marks achieved by the students in the SSC examination, spring 2005 conducted by the Board of Intermediate and Secondary Education, Rawalpindi.

After the declaration of the result of SSC examination, spring 2005, the result cards of the whole sample were taken from the in-charge school record for further statistical procedure.

1.7.2 Population of the Study

(1) There were sixty boys’ secondary schools in District Jhelum in the year 2004. Out of sixty, only eight schools had fulfilled the requirements (number of science students, physical facilities, well equipped science laboratory, science teacher, laboratory attendant/assistant, etc.), set for this study.

(2) There were 100 secondary schools (60 boys and 40 girls) in district Jhelum in 2004-2005. For the construction and validation of the attitude Questionnaire, All the secondary schools of District Jhelum (i.e. boys and girls) during the session 2004 – 2005 were taken as the population for this study.

1.7.3 Sample

(1) Government Comprehensive school for boys, District Jhelum (a typical mixture of the students’ population) was randomly selected as sample school for this study. There were 140 science students in Government Comprehensive high school Jhelum during the session 2004-2005. Sixty-two science students were randomly selected as a sample for this study. The sample was then divided in to two
equivalent groups on the basis of an achievement test of 50 marks from the 8th class science, published by Punjab Text Book Board, Lahore. The marks achieved by the sample students were arranged in descending order. The sample was then divided into two equal matched groups (31 science students in the experimental and 31 in the control group) on even/odd basis. At the beginning of the experiment, each group contained thirty-one students but during the experimental period, one subject of the control group became dead and could not complete the requirements of the experiment. Therefore, 31 students of experimental and 30 of the control group completed the whole experimental period.

(2) To construct and validate the attitude questionnaire (scale), a sample of 200 student i.e. ten from each school (100 boys & 100 girls) was randomly selected from the 20 secondary schools (10 rural; 5 boys & 5 girls, 10 urban; 5 boys & 5 girls).

1.7.4 Administration of the Tools

The tools for this study were administered to the sample at the specified time as mention in the timetable.

1.7.5 Collection, Analysis and Tabulation of Data

With the help of the tools of the research study, the data was calculated, analyzed, classified, tabulated and presented in the form of mean scores. The results of this research study is presented in chapter four. On the basis of these results, findings are made and conclusions are drawn which are presented in chapter five.

1.7.6 Contents of the Study

The content for this study consisted of:


1.7.7 Time Table

The research work was carried out for the period of 35 weeks in the secondary school physics classroom and laboratory of Government Comprehensive School Jhelum. The experimental group was given a treatment i.e. teaching through Ausubel’s teaching strategy, five days per week (i.e. Monday to Friday) in the physics classroom. At the same time, the control group was treated by traditional teaching method by another science teacher.

In the physics laboratory, the students came once per week i.e. every Saturday for one and half an hour. The control group came on each Saturday from 8:30 am to 10:00 am, and the experimental group came from 10:00 am to 11:30 am in the physics laboratory for practical work. For each practical, along with pre-lab sheet, a lecture of thirty minutes was delivered to the experimental group at least three days before the actual laboratory work. Each student with pre-lab was expected to do some preparatory work in the form of pre-lab before he came to the lab.

The researcher developed the pre-lab for each experiment by using Ausubel teaching strategy by highlighting the essential work to be done. To find the effectiveness of the pre-lab, some more work in the form of post-lab was administered to the whole sample (i.e. experimental & control) after the end of each practical. There was a great flexibility in the system, if any student was unable to attend one of his class/pre-lab/post-lab due to any reason; he was invited to attend on the next day. The researcher with the help of lab assistant conducted the lecture /pre-lab/post-lab. The post-labs were consisted of some written work, objective type test-items and some practical activities. The lecture was delivered in the Zero Period before three days of the actual laboratory work.

The timetable was prepared and adjusted with the regular timetable of the school.
The schedule for written and practical examination was set with the help of the school’s controller of the examination.

Table 1.1  

<table>
<thead>
<tr>
<th>Tools of the study</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimenter’s tool I (physics theory)</td>
<td>22 Nov, 2004</td>
</tr>
<tr>
<td>Experimenter’s tool I (physics practical)</td>
<td>23 Nov, 2004</td>
</tr>
<tr>
<td>Experimenter’s tool II (physics theory)</td>
<td>19 March 2005</td>
</tr>
<tr>
<td>Experimenter’s tool II (physics practical)</td>
<td>21 March, 2005</td>
</tr>
<tr>
<td>Term examination I (physics theory)</td>
<td>04 Dec, 2004</td>
</tr>
<tr>
<td>Term examination I (physics practical)</td>
<td>18 Dec, 2004</td>
</tr>
<tr>
<td>Term examination II (physics theory)</td>
<td>23 Feb, 2005</td>
</tr>
<tr>
<td>Term examination II (physics practical)</td>
<td>28 Feb, 2005</td>
</tr>
<tr>
<td>Annual examination conducted by BISE, Rawalpindi, 2005. (Physics theory)</td>
<td>27 April, 2005</td>
</tr>
<tr>
<td>Annual examination conducted by BISE, Rawalpindi, 2005. (Physics practical)</td>
<td>05 May, 2005</td>
</tr>
</tbody>
</table>

1.7.8  Research Design

The posttest only equivalent group design was used for this study. It involved two groups; experimental and control group. These groups were equated by random assignment on the basis of marks achieved by the students in the objective type test from class 8th science book, published by Punjab Text Book Board, Lahore 2002.

The experimental group received a treatment that is teaching through Ausubelian method (meaningful learning). At the end of the experimental period, t-test was used to find the significance difference between the two mean scores of the experimental and control group.
The symbolic representation of the research design is:

\[
\begin{align*}
R \ E &= T \ O_1 \\
R \ C &= -- \ O_2 \\
D &= O_1 -- O_2
\end{align*}
\]

R = randomly selected  
E = experimental  
C = control  
O = observation  
T = treatment  
D = Difference

1.7.9 Analysis of Data

- The Likert scale and t-test were used for the construction, development and validation of an instrument (attitude–questionnaire) to measure ‘scientific attitude’ of the students.

- The independent sample t-test was used to find out the significance difference between the two mean scores at selected probability level (i.e. \( \alpha = 0.05, 0.01, 0.001 \)). The data was then collected, analyzed, classified, tabulated and presented in the mean scores.

- To find the reliability of the instrument (attitude–questionnaire), split half method was used and then the reliability of the full instrument was calculated by Spearman Brown formula, which was 0.9.

- The internal consistency (reliability) of the subscales of attitude scale was found by using chi-square formula.
• The reliability of the experimenter’s tools was calculated by applying Kuder Richardson (KR 21) formula.

• Pearson correlation coefficient was calculated to determine the relationship between students’ attitude scores and the marks achieved by the students in the subject of physics in the annual examination 2005 conducted by the BISE, Rawalpindi.

• To test the hypotheses set for this study, t-test was applied on the data obtained from the sample in the form of achievement score. The hypotheses were accepted or rejected on the basis of comparison of ‘t-calculated’ and ‘t-table’ values.

• The data was analysed by the application of Statistical Package for Social Sciences (SPSS) version 15.
1.8 Definition of Terms

The researcher has used terms in his research with certain meaning which are given below:

**Achievement:**  Accomplishment or proficiency of performance in a given skill or a body of knowledge.

**Acquisition of concept:**  Concept attainment or concept assimilation (as the case may be) determined by knowledge transfer, heuristic transfer, short-term retention and long-term retention of concept.

**Advance Organizer:**  Advance Organizer, an important content, may be a concept or statement of relationship, generally based on the major concepts, propositions, generalizations, principles, and laws of discipline.

**Teaching Method:**  It is an overall plan or pattern to structure knowledge in a way that the students easily grasp it. (The sequence in which material is presented to a learner is the teaching strategy that facilitates learning).

**Traditional Teaching Method:**  The methods of instruction that tend heavily toward classroom lectures, book learning by rote, and memorization of facts, equations, etc. Recitation usually consists of repeating without questioning what the instructor (or book) stated. Knowledge periodically reinforced otherwise may forget.

**Ausubel’s Teaching Method:**  The relationship of pre-knowledge and post-knowledge through comparisons and cross-referencing of new and old ideas to make the learning meaningful. It consists of three principles; (1) proceed from the most generic concepts to the most specific ones. (2) The concepts are meaningful only when the students can visualize them and subsume them in the cognitive structure. (3) Students readiness (which includes current knowledge, stage of cognitive development, and predominant mode of intellectual functioning).
Differential Effectiveness: Relative effectiveness for different student characteristics.

Discrimination: An ability to see slight difference between stimuli or objects.

Evaluation: Qualitative assessment by means of statistical significance.

Previous Knowledge: Knowledge of related concepts acquired in previous grades and it is expected that it have been retained.

Pre-Lab: The activities, which are provided to the students prior to the actual laboratory-work, highlighting the essential ideas of the work to be done. It may be in the form of a lecture, work sheets, written assignment, videos, CAL, simulation etc.

Post-Lab: The activities, which are provided to the student at the end of the actual laboratory work. It may be in the form of written report, viva voce, quiz, post-lab interviews, discussion, or a practical activity.

Attitude: Attitude is the degree of positive or negative effect (or emotional attachment) associated with some psychological object.

Scientific Attitude: A desire for accurate knowledge (curiosity), confidence in procedures for seeking knowledge and the expectation that the solution of the problem will come through the use of verified knowledge.
CHAPTER 2

REVIEW OF THE RELATED LITERATURE

In this age of rapid progress and development, an improvement in science education is highly desirable. How to learn is equally important with what to learn but how to teach (teaching strategy) is more important than what to teach.

This chapter deals with the study of related literature which consists of general ideas, views, rules, teaching and learning models presented by educationists, psychologists, scientists and scholars. In the light of these ideas and views, the researcher intends to clarify his views about science, science education and scientific attitude, concept, concept formation and concept mapping, learning, discovery learning, rote and meaningful learning, and to move towards the solution of the problem set out for this study.

Science education has been the subject of much attention in the 20th century around the modern world and now it is an emerging trend in the developing countries like ours. According to Kempa (1976), “we have witnessed a steady increase in the number of researches dealing with the learning and teaching of science. Evidence for this is readily provided by the appearance, during this period, of several new journals especially devoted to science education issues and the establishment of science education departments.”

It is an interesting observation that, by the end of 2008, there will not be one research center left which is devoted to research in science education anywhere in the United Kingdom. The growth of new journals has almost ceased in the west. However, there is increasing growth in science education research for learning with university students.
2.1 Meaning and Scope of Science

Science is a way of knowing, to know through the processes of observation and experimentation. The strength of science lies in its ability to ask questions about the objects and natural phenomena, and get answers, which can be interpreted and built up into a meaningful knowledge. Woodburn and Obourn (1986) in Kumar (1995), states that science as that human endeavor that seeks to describe with even increasing accuracy, the events and circumstances which occur or exist within our natural environment. Science concern itself with questions, which can be answered by reproducible measurement. A Rainbow (spectrum of seven colours) is a natural phenomenon. Each colour of rainbow has its unique frequency, which can be measured with an appropriate instrument answering the questions, what is the frequency of red light? Why we use red colour as a sign of danger/stop? Do you like red colour? It cannot be answered by measurement and fall into the area of aesthetics rather than science. According to Gupta (1995), “Science is an organized body of knowledge which attempts to explain phenomena (natural or man made). Wood (1991), in Zaman (1996), remarks that science requires rational, analytical processes but it also needs creative, intuitive processes.

Science is broadly based human enterprise that may be defined differently by individuals who view it. A layman defines it as merely a body of information, philosophers may regard it as a way of questioning the truthfulness of knowledge and a scientist may view it as a method by which hypotheses are tested. Kumar (1995), quotes Fitzpatrick that science is a cumulative and endless series of empirical observation which result in the formation of concepts and theories being subject to modification in the light of further empirical observation. In the view of Baddeley (1994), science is an attempt to understand and represent nature, to understand human memory, and to express these understanding in some coherent way: a theory, a law or a model. He further goes on to say that science operates by attempting to expose such conceptualizations or models to empirical test, to see if they actually work when applied to a situation that is novel.

According to Singh and Nayak (1997), “the true test of a theory in science is threefold: (i) its ability to explain what has been observed; (ii) its ability to predict what
has not been observed: and (iii) its ability to be tested by further experimentation and to be modified as required by the acquisition of new data.” The same authors go on to say, that “science has three major elements processes, products and human attitude.”

The method or process adopted by science in the explanation of truth is quite unique and distinct, and has such qualities as soundness validity, reliability, impartiality, objectivity etc. it is a principal way of testing theories under conditions where as many extraneous variables as possible are controlled or ruled out. Kumar (1995), explains that science has two important approaches: (i) science as a product; various laws, theories, principles etc. are included in this category, (ii) science as a process, includes scientific method, scientific attitude etc. Although both aspects are important in their own ways but to achieve the objectives of science education at the secondary level more emphasis is placed on process approach.

2.2 Importance of Science Education

In science teaching we are not only providing the theoretical knowledge to the students but also use another form of knowing i.e. the experimental skills. Kumar (1995), quotes Bernord (1960) says, “Science education is a creative intellectual activity leading to unifying concepts of man’s natural environment and the application of these concepts to the control of the environment for man’s benefit.” He further goes on to say that “it is a human enterprise, which requires man’s best efforts to sustain it at an optimum level of productivity.”

The main purpose of teaching science in secondary schools is to enable students to grasp systematically the basic knowledge of physical sciences needed for further study of modern science and technology and to understand its applications. It should help them to acquire experimental skills, develop the ability to think and to use mathematics/statistics to solve the physical problems. In teaching and learning science at school level, the students face many problems in understanding scientific concepts, theories, and laws in the science classroom and laboratory. In the opinion of Wood
(1991), “science education should be more about the learning of scientific processes than the learning of scientific facts.”

According to Zaman (1996), present age is known as the age of science and so science is considered an important subject in the school curriculum. Science Education enables the students to identify and solve scientific problems and to do research in new areas of knowledge. In this era of science, large numbers of people are being employed in scientific pursuits and for this they need knowledge of science. The dawn of space age and explosion in knowledge, have also necessitated the teaching of science to every student.

A simple analysis of any typical school population will show that only a tiny minority (much less than 10%) will pursue any type of science career. Therefore, any attempt to plan science education to produce those who will engage in ‘further study of the science’ is aiming at a minority not the majority. It is unsustainable as a goal.

There is no evidence whatsoever that the science-based skills, which may or may not be acquired in school science education, transfer into any other area of life. The evidence suggests they do not. There is no evidence that science education enables students to identify and solve scientific problems and do research. These are skills attained by very few and they are developed at a much later stage in life.

Taba, (1962), says that among all types of education, science education has not changed the face of earth but man himself. But she seems utterly naïve. Science is not essential for the purposes she states. The majority in most countries live their lives quite happily and successfully without this knowledge. While science does offer one tool for thinking, that tool is limited in its application. There are many other thinking tools which are not unique to the science.

According to I.B.E. UNESCO, (1986), science is essential for understanding the world through knowledge of the laws of nature. It also provides man with a tool for organizing his thinking and for classifying his experience. Science and technology
education can make a decisive contribution to improving our standard of living and to impart the basic scientific and technological knowledge necessary for the younger generation to carry out an increasing number of occupations, especially in productive sector. The teaching of science and technology education is also a powerful means of stimulating creativity among young people.

Science and technology are not neatly related. Technology does not grow out of science in any systematic way it often develops quite separately – history shows this clearly.

It does not follow that the space age and knowledge explosion mean that school pupils must understand science. For example, no understanding of physics is needed to drive a car, to use the electrical supply of a house, to work a computer.

In the opinion of Kumar, (1995), “The most significant aspect of modern science is the impact it has had in solving a variety of problems of practical and technological importance as well as those related to the pressing problems of mankind. A large number of these problems require a proper understanding and application of scientific principles and processes”. Mentioning the importance of science education to meet the needs of food, power and transportation, communication etc., Amjad, (1991), remarks, that continuous scientific research is needed to discover and invent new sources of power, food, communication and transportation. Of course, science can offer ways forward in solving the problems of starvation and can lead to new medical treatments. However, history shows that no one will benefit if the structures of society (and the politicians and decision takers control this) do not make it possible. Science advance is helpless to achieve that. Look at solar (photovoltaic) energy. This may offer some answer to the long term energy needs of mankind. However, the decision about research to find answers is taken by the governments and leaders, not scientists of any sort.

Zaman, (1996), citing the views of Sheikh (1984), “in science education, the children develop of their own accord a scientific way of observing and thinking, and
carry out experiments.” It presents new concepts, develops appreciation, including the joy of discovery and desire of study and develops a strong desire to see the truth. In this way all human potentials are awakened and developed. The children investigate phenomena in the natural world, notice natural laws, make clear the relation between phenomena and observe nature as a whole. Thus, science education aims at the formation of human character, which includes the formation of view of nature itself. Science education brings the science knowledge necessary for living positively in the world of science and technology.

There is no evidence that children develop these skills of their own accord. Science at school levels rarely involves discovery in any real sense. Children do not make the connections easily between what is seen and what underpins it. Science has nothing to do with the formation of human character—that is absolutely wrong and without any empirical support. Science does not lead to living positively nor does it hinder it. Science is neutral in morality terms. It depends upon the individual people.

Science education finds a large number of applications in our daily life. For proper utility of such applications some knowledge of science is necessary. Kumar, (1995), explains the importance of science education due to the following reasons:

(i) Intellectual value (Sharpen intellect and promote intellectual honesty).
(ii) Vocational Value (essential for much vocational knowledge).
(iii) Aesthetic value (scientists seek for truth and truth is beauty).
(iv) Practical value (applications of scientific laws and principles).
(v) Moral value (truthfulness).
(vi) Psychological value (learning by doing).
(vii) Cultural value (study about the past scientists and their discoveries).
(viii) Adjustment in modern life (Scientific outlook, scientific attitude).
The quote from Kumar is simply wishful thinking and is largely unsupported by any evidence. Indeed, some is contradicted evidence. For example, the learning by doing is false: doing sometimes hinders learning as Johnstone and Wham (1982) found.

Truthfulness in sciences is not the same as the moral value. Kumar presented simply opinions and they are often simply wrong when the evidence is considered. However, this leads the question: Why do we do sciences at school level? Here are some suggested answers.

(i) Piaget (1962) showed that learners are seeking to make sense of the world around; physical and biological. The sciences are consistent with that.

(ii) The sciences are part of culture. They involve human endeavour. Young people need to know something of this simply to become a full member of their own culture and the wider culture of the world.

(iii) If the sciences are taught in the right way (and I have almost never seen this at any level), they can introduce the learners to one powerful way of knowing: the contribution of science education is to enable young learners to see that experimental evidence is one powerful tool in making sense of the world around.

For a few, this may lead on to more complete scientific thinking.

It is essential that all school learners have some understanding of the sciences in that they will all be members of society, perhaps voters some as leaders. Society as a whole needs to see how the sciences can make a contribution for the benefit of all. Reid, (1980), summarises the above discussion in the figure 2.1 presented below:
2.3 **Meaning, Scope, and Importance of Physics**

Gupta (1989), states that Physics is the study of properties of matter and energy. It concerns both the macroscopic and microscopic states of matter. In the broader sense, physics is that branch of physical science, which explains the property of matter and energy and the relationship between them.

Zaman (1996), sketches the views of Asian Programme of Educational Innovation for Development (APEID), (1978), “It is a quantitative science and in the earlier period of its genesis, it was studied under the heading of heat, light, sound and electricity. Because of the increasing researches in Physics, some other branches of Physics have emerged such as atomic Physics dealing with the atom and atomic structure, nuclear physics dealing with nucleus of an atom, solid state physics dealing with matter in solid state have definite properties and explanations there of, Astrophysics, Geo-physics Biophysics, Physical chemistry, and so on. During teaching physics the science teacher can
correlate his topic with some other branches of science. For example, during study of light in physics we can tell the students about the effects of light on health and can discuss the topics as light and germs; sun bathing; eye and camera. The study of heat can be correlated to body temperature, heat and energy etc. While discussing a lesson on sound teacher can discuss the functioning of ear, effects of noise on health, ultra sound and its uses etc.

Physics has succeeded in getting an important place not only in science education but it has also played a crucial role in the service of mankind. Physics contributed in all aspects of life perhaps more than any other field of science, to the economic growth and development, and regarded as the backbone of a country for its progress and prosperity. Kumar, (1995), stated that the knowledge of physics is applied in various ways in our life. We can look at a very large number of electrical and electronic devices which all utilize one or the other principle or law of physics. Heat engine, Electrical motor, Television, Radio, Electronic Watches, Mixers, Juicers, Washing Machines etc., all utilize the knowledge of physics. Thus physics has a utilitarian value in life. He further explain that the discoveries of telephone, fax, telex, computer, e-mail and internet services have decreased the distance between nations and thus they have provided the basis for a corporate living, coexistence and better human relations. All these lead to development of social standard both in personal and professional life. The World book Encyclopedia (1968), states that Physics, today, is one of the most active and the most important of all sciences.

Physics teaching–learning process provides more possibilities of involving children in such activities as liked by the students. Zaman, (1996), citing the saying of Nagy, (1972) that importance of Physics has been realized in its teaching and learning processes, because the current college /university population explosion, the exponential growth of information and the usually inadequate pedagogical background of instructors accentuate the need for higher accuracy and precision in.... physics teaching and learning.
Physics has provided us with a large number of devices such as television, radio, cinema, computer etc., which are a source of entertainment to all of us. These are also a source of knowledge and are used for spread of mass education and making the community aware of dangers of various ills. Kumar (1995), citing facts about teaching of physics in China; (i) the purpose of physics teaching in secondary schools is to enable students to grasp systematically the basic knowledge of physics needed for further study of modern science and technology and to understand its applications. (ii) It helps them to acquire experiment skills, develop the ability to think and use mathematics to solve physical problems, cultivate a dialectical materialistic viewpoint and make them aware of the need to study hard and struggle for modernization. Physics teaching provides more opportunities of carrying out practical work in comparison to social sciences, which are less practical in nature.

2.4 Science Teaching

Science is more than merely a body of knowledge. It is also ways of investigating. If we do not teach our students about science inquiry, then we must create a classroom environment that encourages and guides them to use scientific processes every day. Carin and Sund (1989), presented some guides to involve children in “doing science”.

a. Involve students in science-based process activities.
Include activities such as observing, measuring, experimenting, communicating, inducting, deducting, forming hypotheses, analyzing and synthesizing, evaluating, estimating, speculating, extrapolating, creating theories. Students must engage in scientists’ work at their own maturation level.

b. Teacher must acquire knowledge of science and the ways science and society are interdependent.
To assist students in understanding how people impact upon each other and their environment, and help them to understand the attitude and values of society, so they can make informed decisions.
c. *Engage students in activities involving seeking answers to problems in our scientific and technological society.*

d. *Students must learn by doing and then reflecting.*

Actively involve students in scientific activities so they investigate and discover scientific concepts, theories, and processes; help them learn how to think what they have done.

e. *Utilize as many different approaches to science teaching/learning as teacher can.*

Expose the students to science through telling, showing, guiding, listening, reading, drawing, handling, and visiting.

f. *Actively involve your students in inquiry or guided discovery approach to teaching or learning.*

The evidence from Piaget (1971) shows very clearly that most of these processes are inaccessible simply on maturational or developmental terms to learners until over age about 15. For example, the concept of the hypothesis is simply not possible for the vast majority of school pupils until quite late on, no matter how they are taught. It is developmentally inaccessible. The later statement that students ‘must learn by doing and then reflecting’ looks confusing. They sued the word ‘doing’ to mean practical activities. They are wrong. Doing practical may or may not help. ‘Doing’ in the intellectual sense of mental activity is what is right. But they do not say this.

An understanding level of teaching and learning seeks to acquaint a learner with relationships between principles and facts. Herbart in Kumar (1995), states that the teacher should follow these steps when teaching physical sciences particularly.

1. **Preparation**

   A teacher should begin with experiences that pupils already have had. This will help to prepare students to receive new information. This step involves:
   - Reviewing previous knowledge of students;
• Providing enough opportunity to motivate students; and
• Introducing the new information.

2. Presentation
A teacher should announce the topic to be dealt with before dealing with the related contents. Teaching methods, which can be used, are lecturing with examples, demonstrations, discussions and teacher’s explanations in relation to facts, concepts and principles. A teacher should try to involve students as regards their participation. A questioning technique should be employed for this purpose. Teaching aids must be used for developing conceptual understanding.

3. Comparison and Abstraction
This step comprises finding out the similarities and differences among the old and the new ideas and then welding them together.

4. Generalization
This step deals with the identification of some common elements of the two sets of facts as a principle or generalization.

5. Application
This step deals with the use of the newly acquired principle to explain further facts.

6. Recapitulation
An understanding of contents is tested through questions. Test items of different types are used for the purpose.

2.5 Laboratory Teaching
Laboratory is a spacious room where the students in groups carry out their experimental work. It provides many opportunities for students to talk and write about science. With a little thought and planning on the part of the students, its activities can be
the basis for building communication and problem solving skills. Zaman (1996), citing
the views of Kempa (1986) “the process of practical work has stages which are widely
known as forming a valid and satisfactory framework within which practical skills are to
be developed and assessed.

(1) Recognition and formulation of the problem.
(2) Planning and designing of an investigation in which the student predicts the
results. Formulate hypotheses and designs procedures.
(3) Carrying out the experiments in which the student makes decisions about
investigative techniques and manipulates materials and equipment.
(4) Observational and measuring skills.
(5) Analysis, application and explanation in which the student processes data,
discusses results, explores relationships, and formulates new questions and
problems.

Kumar (1995), thought that the Heuristic method is preeminently a laboratory
method. However, from this it should not be concluded that Practical work in laboratory
is impossible if the teacher uses any other teaching method. Thus irrespective of the
method adopted by the teacher for teaching of physical science, practical work in the
laboratory must be attempted. Practical activities in a controlled environment (laboratory)
have been traditionally an important feature of science.

2.6 Objectives of Laboratory Work

Practical work forms a prominent feature in any science course. Kumar, (1995),
states that class room experiments help in broadening pupil’s experience and develop
initiative, resourcefulness and cooperation. Gupta, (1995), pointed out the main
objectives of laboratory work, these are:

a. Create interest in science;
b. Verify facts taught in theory classes;
c. Develop the habit of doing independent work among students;
d. Prepare students for higher studies and science careers;
e. Develop skills in handling specific science apparatus and equipments.
f. Improve observation and critical thinking;
g. Develop the habit of reasoning;
h. Have a clear understanding of science concepts;
i. Develop the habit of doing systematic work; and
j. Create interest for research.

Gupta list is a good analysis and worth considering. However, some of his aims need justification. For example, if we want to develop independent work skills, then a laboratory is not the best place to do this and it is expensive in terms of resources and time. Why should we want school pupils to develop experimental skills—will most of them every need them or use them later in life. ‘Verify facts’ is anti-science. The method of science derives its understanding from experiments, not the reverse. Gupta does not understand the real nature of science.

2.7 Organization of Practical Work

According to Kumar, (1995), and Gupta, (1995), the following guide-lines will help the physical science teacher to make his practical work effective.

(i) If teacher is following the demonstration method to teach theory, he should remember the most important principle that practical work should go hand in hand with the theoretical work.

(ii) To arrange the practical work in such a way that each student is able to do his practical individually. Thus, for practical work individual working is preferred in comparison to working in groups.

(iii) In case of a large class, it is convenient to divide that class in a suitable number of smaller groups, for practical work.

(iv) To save time on delivering a lecture about do’s and don’ts in laboratory, card system be used. This card contains certain amount of guidance printed on it and is given to each pupil. Student can complete his practical work according to instructions given on the card.

(v) The apparatus provided should be good so that students get an accurate result.

(vi) A true faithful record of each and every experiment is kept by pupils.
(vii) Teacher should see that students enter all their observations directly in their practical note–book.

(viii) While working with large class and with limited apparatus teacher may allow students to work in groups.

(ix) During a practical, class teacher would observe all children in such a way that his power of control over the class should be such that students continue their work satisfactorily.

2.8 Pre–Laboratory Activities

Expecting students to engage in laboratory activities without some form of prior consideration may leave them feeling insecure, and result in a rather poor understanding of what is happening. Students often have difficulty in completing the necessary calculations relevant to the experiment and to the laboratory report. This lack of preparation may make the laboratory experience less than ideal and may lead to the development of negative attitudes. It is therefore useful to engage them in some form of pre-lab activities highlighting the essential ideas of the work. These activities provide the students to reflect on what has happened and to check on any aspects of information that they are unsure about.

Pre-laboratory exercises can be used to remind students of ideas which have been forgotten or to develop ideas which are yet to be taught. They may also seek to make the link between the underlying physics and the practicalities of the actual experimental observation.

The literature survey revealed several kinds of pre-lab work/activities for example, (a) reading the laboratory manual before starting the experimental work, (b) solving theoretical problems relating to the experiment before coming to the lab course, (c) doing computer simulations of experiments, (d) listening to a short talk about the most important points of experiment in the first half hour of the lab session, (e) understand audio-visual preparation and so on.
The importance of previous knowledge in the learning process has been stressed by educationists and psychologists and it has also been the subject to several investigations. Students’ preparation before starting practical work should increase the chances of their understanding what they are doing in the lab. This is intended to avoid a ‘cook book’ or ‘recipe following’ scenario. (Zaman, 1996)

According to the nature of the experiment and in the perspective of the psychological model of learning science, presented in figure 1.1, pre-lab sheets were developed for twenty experiments. These pre-labs were constructed under the headings and responses such as: (a) what does it do? (b) How does it work? (c) What will it measure? (d) What should I know before I begin? (d) …. And so on. Some other supplementary but necessary information was also provided to the students, according to the demands of the experiment.

The aim of the pre-labs was to prepare the students to take an intelligent interest in the experiment and make the material more understandable for the students by knowing where they are going, why they are going there and how they are going to get there.

One of the criticisms of laboratory work is that the emphasis is usually on the methodological aspects of the exercise. Thus even if the exercise is well designed, and the student produces a set of results or observations, these are not readily related back in a meaningful way to the conceptual framework that underpins the experimental work. The experimental results are isolated from theory, and the experiments can appear to be trivial and out of a scientific context.

At the base of the V are the events or results that occur as an outcome of some experimental activity. On the left hand side are the theoretical aspects of the work, increasing in generality from the bottom of the V, where specific concepts are cited, to general theoretical schemes at the top. The right hand side is concerned with the methods used to generate knowledge, again arranged in hierarchical order from records taken of the events to generalized knowledge claims. They further describe that the major purpose of the V is to help students understand the function of laboratory work in science; it is particularly useful if constructed as a pre-laboratory activity. The teacher might construct a V map in a tutorial session, building up the Connections between theory and method by starting with the discussion of the event being observed. This leads to a discussion of what records might be taken and what concepts were used to guide observation of these particular events, or take these particular records. An alternative approach is to provide some aspects of the V and then expect students to complete the maps as an individual
exercise. V maps can also be included in laboratory manuals. He further goes on to say that the major value of V map is that students can be developed as an active consideration of all the facets of experimental science, and not just the methodological features. The V encourages students to think as scientists before they enter the laboratory rather than behave as recipe followers.

In developing the set of twenty pre-laboratory exercises used here, the first step was to look at the experimental work in detail and to define the key underlying ideas which would be necessary to make sense of the work. The specific pre-laboratory tasks were then design to ensure that these key ideas were understood. The set of pre-laboratory exercises were given to several experienced staff members, experts related to the field of science education for comments and then adaptations were incorporated.

2.9 Post-Laboratory Activities

Johnstone (1998) stated, “Post-labs should introduce to allow students to re-explore what they had learned in the laboratory and utilize that to solve some relevant practical problems. It was hoped that by attempting and succeeding in the post-lab work they would be able to arrange and interlink the material in a meaningful way.

According to Johnstone (1998), “Post-labs give students the opportunity to plan and design their own strategy and draw conclusions from experimental results, think independently and develop skills in solving problems presented in the post-lab sheets.”

Post-laboratory work is usually interpreted at the secondary / college level as the preparation and submission of a written report. This is marked by someone associated with the laboratory (science teacher, demonstrator etc.) and then returned to the student with a grade and some written comment. According to Bond, David Jeffery and Elizabeth, (1986), Post-laboratory work provides the students an opportunity to demonstrate various skills of calculation, communication and application. Researches show that other forms of post-laboratory activities, particularly interviews and discussions, enhance student learning.
The complete neglect of post-lab discussion is especially disturbing since this phase may serve as one of the best occasions for developing and practicing intellectual skills as well as for conceptualization and deeper understanding. The post-lab is essential for problem solving investigative labs.

Bond et.al. (1986), state that post-lab interview is a valuable feedback device, as well as a means of developing students oral communication skills. Zaman, (1996), and many other researchers have used post-lab work to develop the communication and problem solving skills in the students.

2.10 Concept and Concept Formation

One of the most important issues in cognitive psychology is the development or formation of concepts. According to Huiii (2003), a concept is the set of rules used to define the categories by which we group similar events, ideas or objects. Carroll (1964) defines that a concept is an abstraction of a series of experiences that defines a class of objects or events. It is instructive to remember that abstraction is the process of focusing one’s attention on a particular situation and extracting certain elements while ignoring many other elements. Dressel (1960) thought that a concept is an abstractions which organize the world of objects and events into a smaller number of categories. He further states that although the word concept is often restricted to ideas descriptive of classes of objects or events, such as ‘tree’ or ‘motion’, generalizations and principles (principle of lever) may be treated as concept.

Bourne (1966), states that “a concept exists whenever two or more distinguishable objects or events have been grouped or classified together and set apart from other objects on the basis of some common feature or property characteristics of each.”

According to Bruno, F.J. (1986), concept formation is the learning process by which we create cognitive, or mental, classes. Bruner, Goodnow, and Austin (1956), report many findings of interest about concept formation that it is the tendency of the
human beings to use cognitive strategies, consciously applied plans and hypotheses, to reduce the time taken to form a concept. According to them concept formation is an active and forward-looking process in human being, not a passive one.

In the view of Garone (1960), “Concepts are not always arrived at directly. Frequently, much thought is involved in their development. It is important for teachers to realize and to appreciate how much children think about their experiences and work to integrate them into satisfactory understandings.”

Concepts change for each individual as he gains greater experiences and understanding. It should not be assumed that all children at the same level of learning will formulate identical concepts of the same item. Each individual will interpret natural phenomena in terms of his own experience. A pupil’s environment and his prejudices will affect concept formation. Huit (2003), presents several principles that lead themselves to concept development.

- Name and define concept to be learned:
  a. Reference to larger category.
  b. Define attributes.
- Identify relevant and irrelevant attributes (guided discovery).
- Give examples and non-examples (tie to what is already known--elaboration).
- Use both inductive (example/experience-->definition) and deductive reasoning (definition--> examples).
- Name distinctive attributes (guided discovery).

Direct experiences are essential in concepts formation. Pupils in the lower grades are more concerned with what happened in observing individual experiments and older children seek the answer to the question “why”. Educationists compared pupils in grades 1 & 3 as they played with magnets and other articles. Pupil observation during individual experimentation played vital role in formulation concepts.
Bruno, F.J. (1986), concepts are formed in three ways; (1) Conjunctive concept, one in which two or more defining attributes are joined to form the concept. (2) Disjunctive concept is of the either/or variety. (3) Relational concept creates some sort of ranking or ordinal scaling among objects of perception.

Concept formation should be evaluated by pupil’s ability to transfer and apply knowledge and experience in new problems. It is for this reason that problem solving skills are excellent means for teaching science concepts, attitudes, and solutions to problems.

2.11 Concept Attainment

Classifying, or categorizing, is a skill that has been studied by psychologists because it is basic to thinking. Bruner, Goodnow, and Austen (1956) have pointed out that categorizing reduces the complexity of our environment and make sense out of it. They emphasize that individuals invent categories and form concepts as a way of adapting to the environment.

According to Collette and Chiappetta (1989), “concept learning is an active process that is fundamental to understanding science concepts, principles, rules, hypotheses, and theories.

Bruner, Goodnow, and Austin (1956), in Collette and chiappetta (1989) state that a concept has five important elements: (1) name, (2) definition, (3) attributes, (4) values, and (5) examples. They believe that all these elements are necessary for understanding concepts and that these elements can be the focus of instruction for concept attainment. Each one is now discussed briefly.

1. Naming/Labeling

It identifies what is being studied and recalls to the learner’s mind a given concept that he/she has attained. During the process of attaining a concept (that has been invented by someone else,) the learner determines the criteria by which attributes are associated
with a category of objects or events. The learner may have a preconceived idea or notion of the concept through past experiences when concept was formed. Further concept attainment occurs as the learner more precisely defines the critical attributes of the concept. This is usually done by exposing students to examples and non-examples of the concept (As Ausubel suggested). Once the concept is fully attained, the naming of the concept permits the recall of the precisely defined concept. For example, the word *screw gauge* will probably evoke the idea of an instrument that measures the length/diameter (of a wire, small ball) accurately up to 0.001cm.

2. Definition

The definition of a concept provides a statement of the relationship among the essential characteristics, or attributes, that constitute the concept. The definition includes both the relevant attributes and the rule for combining or using these attributes. Collette and Chiappetta (1989), state that there are numerous classification schemes for concept, each of which utilizes a different type of definition. They further elaborate the views of Bruner, who says that the three types of concept of definition are conjunctive, disjunctive, and relational concepts.

According to Collette and Chiappetta (1986), definitions of conjunctive concepts combine a given set of attributes and values together. This definition states, which characteristics add together to specify a concept. For example, both the attributes of weight and volume must be considered together in formulating the concept of matter, if matter is defined as that which has weight and occupy space (volume). So the rule in this example involves the use of the conjunction between two attributes, weight and volume.

Definitions of disjunctive concepts combine sets of attributes in an “or” fashion. This type of definition identifies the combination of attributes that form a given concept. For example, an ion is an atom that has lost or gained one or more electrons. Another example is: “Equilibrium is that state of a body in which the body may be at rest or in the state of uniform motion.”
Disjunctive definitions are more complex than conjunctive definitions, and consequently their respective concepts are more difficult to learn. With a conjunctive concept, all relevant attributes and values must be displayed in each positive instance. However, with a disjunctive concept the positive instances need not have the same stimulus characteristics. A sodium atom that has lost an electron and a chlorine atom that has gained an electron are both ions even though their stimulus characteristics are not the same. Similarly in the second example, a body at rest and a body in the state of uniform velocity are both in the state of equilibrium even though their stimulus characteristics are not the same.

Relational definitions specify a relationship between the relevant attributes. An example of a relational conception is: “An acidic solution is one that has a higher concentration of H$^+$ ions than OH$^-$ ions.” The concept of acidic does not depend on the exact concentration of the H$^+$ ions and OH$^-$ ions, nor does it depend singly on the volume of the solution. It depends only on the relationship between the concentration of H$^+$ ions and OH$^-$ ions.

Other examples are: (1) Resonance in an electric circuits “Resonance is the condition in an AC circuit in which the inductive reactance and the capacitive reactance are equal and cancel each other.” In this definition of resonance the two essential components (inductive reactance and capacitive reactance) can exist in any amount, but their relationship must be such that they are equal and cancel each other’s effect. (2) Resistance in an electric circuit (the physical property of a conductor) “Resistance is that property of a conductor in which the conductor prevents the flow of electrons in the conductor.” According to Acuman, P.I (2005), states Ohm’s law as, “the current passing through a conductor is directly proportional to the potential difference applied across its ends, provided, that the temperature and the other physical conditions of the conductor are kept constant.” (i.e. $V=IR$ Where $R$ is the resistance of the conductor) If the value of voltage is altered then the value of current is also found to change. Hence the “resistance” of the conductor can be calculated by finding out the relationship ($V/I$) between voltage and current.
Like disjunctive concepts, relational concepts are generally more difficult to form and attain than conjunctive concepts. In the attainment process, the students must not only learn how to identify the critical attributes but also learn the relationship among these attributes.

3. Attributes and Values

Attributes and values are the characteristics that define concepts, and they are the discriminable features of an object or event. Attributes are the broad characteristics which vary in quality or quantity, which represents their value. Let us consider classifying motion of different bodies. There is at least one attribute that one can use to categorize the motion of a body.

Translatory motion is that motion of a body in which every particle of the body is being displaced by the same amount, e.g. a car moving on the road, falling bodies. Rotational motion is that motion of a body in which a body spins or rotates about a fixed point or axis, e.g. the motion of earth about its own axis, the motion of electrons around the nucleus.

Vibratory/Oscillatory motion is that motion of a body in which a body executed to and fro motion in regular intervals of time, e.g. the motion of a simple pendulum.

In teaching science concepts, Ausubel’s idea of progressive differentiation is illustrated in the attribute/value relation. Attributes represent the more inclusive and abstract level of this hierarchical relationship, and values represent the more concrete and specific level of the relationship. If one desires to teach a body of information from a concept learning approach, he/she could begin by distinguishing and labeling the attributes of the concept first, followed by a careful study of the values of these attributes, thus progressively moving from the general to the specific ideas.

Herron et.al. (1977), have attempted to characterize the abstract nature of concepts: (a) concepts with perceptible instances and perceptible attributes, (b) concepts
with perceptible instances, but with no perceptible attributes, and (c) concepts with no perceptible instances, and no perceptible attributes. Perceptible entities can be observed and tend to be more concrete than imperceptible entities.

Some science concepts are concrete in nature, with perceptible instances and perceptible attributes (e.g. Meter rod, Vernier Callipers, and Spectrum). These concepts present very little difficulty when they are given to students.

In the views of Collette and Chiappetta (1986), some concepts have perceptible instances but have attributes that are imperceptible. Herron and others (1977), cite element and compound as an example of this type of concept. An element can be perceived; iron, gold, sodium and carbon can be observed directly. However, the fact that each element is composed of only one kind of atoms is not possible to perceive, so that the attribute of the constituency of the atom is imperceptible.

Collette and Chiappetta (1986), further describe that many concepts in science have no perceptible instance. For example, atoms, ions, molecules, nuclei, angstroms, and light year, cannot be perceived because of their size. Such entities may be difficult to understand for some learners because they cannot be perceived directly. These concepts can be taught by illustrating them through models and diagrams, where their attributes are made evident through visual means i.e. show me and I might remember (Alavi, 1994).

4. **Examples and non-examples**

Examples and non-examples should be used in teaching concepts. Researches show that provision of examples (positive instances) and non-examples (negative instances) is a major condition of learning. With regard to the number of examples, Gagne (1970), suggests that enough examples should be presented to ensure a good representation of the concept being taught. Huttenlocker (1962), studied the ease of concept learning under three different conditions. In one condition only concept examples were used, in a second condition only non-examples were used, and in the third condition both, examples and non-examples were used. Huttenlocker found that the student learned
the concept most easily when both examples and non-examples were used. Braley (1963), and Yudin and Kates (1963), support the finding of Huttenlocker, that both examples and non-examples should be given of the concept being taught. They further suggest that when only example or non-examples can be used, the use of all examples, as opposed to all non-examples, would best facilitate concept acquisition.

Ausubel (1960) describes that, “to present the content in terms of basic similarities and differences, specific examples should be used. To learn new material, students must comprehend the similarities between the material presented and what they already know. They must also see the differences so that confusion can be avoided. Along with the comparisons, specific examples must come into play. The best way to point out similarities and differences is with examples.”

2.12 What are Attitudes?

According to Reid (2003), “Attitudes express our evaluation of something or someone. They may be based on our knowledge, our feelings and our behaviour, and they may influence future behaviour. In the context of studies in the sciences, attitudes are evaluations which may influence thinking and behaviour. An attitude must have a target. We have an attitude directed towards something or someone. Attitudes are highly complex and can affect learning extensively.”

In the opinion of Reid & Skryabina, (2002), there are four broad areas where we might wish to explore attitudes in relation to students.

a) Attitudes towards subjects being studied;
b) Attitudes towards study itself;
c) Attitudes towards the implications arising from themes being studied;
d) The so-called scientific attitude.

1. **The Emotional Component**
   
   Attitude may include cognitive and behavioural components as well. However, it is evident that attitude is an affective characteristic, and that emotions are involved. The feeling can be positive, negative or somewhere in between.

2. **The Target**
   
   Feelings are directed towards or away from some target that may often be an abstract idea. The most common targets in educational research and evaluation involve objectives that are associated with the school and specific curricula of subject areas within the school (e.g. reading, mathematics).

3. **Direction**
   
   Attitudes are feelings, which are directed toward or away from some target. When attitudes are favourably directed towards the target, they are said to be positive. Likewise, when attitudes are directed un-favourably towards the target, they are said to be negative. The measurement of attitudes typically begins with the identification and specialization of opposite statements and adjectives, which involve the ideas of favourable or unfavourable, like or dislike, satisfied or dissatisfied.

4. **Intensity**
   
   Not only attitudes differ in their direction, but they also differ in their intensity. Some people experience and express more intense feelings than do others. Practically speaking students who cannot wait until they get to school are different in terms of the intensity of their attitudes from those who enjoy school once there.

5. **Consistency**
   
   The consistency of an attitude relates to the strength of an individual’s feelings toward a particular object in different settings or situations. It differs from the stability of attitudes over time, and the interrelatedness of Kindred attitudes, which may involve a more deeply internalized world view.
2.13 The Importance of Attitudes

In the view of Ernest, (1994), “surveys of attitudes about courses, subjects and school in general can be a first step.” Reid (2003, p.33), states, “attitudes are important to us because they cannot be neatly separated from study. It is a relatively quick series of steps for a student with difficulty a topic to move from that to a belief that they cannot succeed in that topic, that it is beyond them totally and they, therefore, will no longer attempt to learn in that area. A bad experience has led to a perception which has led to an evaluation and further learning is effectively blocked.”

In general, attitudes in life allow us to:

\[ a) \text{ Make sense of ourselves; } \\
\quad b) \text{ Make sense of the world around us; } \\
\quad c) \text{ Make sense of relationships; } \]

Reid (2003) further says, “we want our students to make intellectual sense of the world around them-that is the very nature of the subject matter of the physical sciences (and other sciences) of course; it helps them to contribute to the understanding of the world if they can also make sense of themselves and others.”

A very useful analysis was carried out by Perry (1999), and this has led to a useful framework for analyzing students’ attitude to work under the four headings:

\[ (a) \text{ Student’s perceptions of the nature of knowledge; } \\
\quad (b) \text{ Student’s perceptions of the role of the lecturer in their learning; } \\
\quad (c) \text{ Student’s perceptions of their own role in learning; } \\
\quad (d) \text{ Student’s perceptions of the nature and role of assessment. } \]

The above discussion can be summarised as presented in the figure 2.3
Johnson (1979), states that the purpose of assessing students’ attitudes is to use information to modify and improve instructional programs. Attitude should have no effect on students’ grades, and teacher should not be evaluated on the basis of whether or not their students have positive attitudes. But components of instructional program such as teaching strategies and curriculum materials can be modified on the basis of the students’ attitudes they promoted.
2.14 Attitudes in Science Education

Traditionally, teachers neglect the teaching of attitude. They state that it seems wise in many school districts to be cautious about the role of school in influencing acquisition of attitudes. Whether teacher likes it or not, students acquire attitudes as a result of their experiences in school. They further say that the development of positive attitudes by students may be more important than the mastery of specific knowledge and skills.

In the view of Johnson, (1979), “attitudes are a combination of concepts, verbal information, and emotions that result in a predisposition to respond favourably or unfavourably toward particular ideas, events, objects, or people.” Attitudes are useful in a sense that they give people a simplified and practical guide for appropriate behaviour. Positive attitude toward learning, subject area, and teaching strategy are all-important because they affect student motivation to learn, and continuing motivation not only to apply and utilize what has been learned but also to seek out further related opportunities. Many educational psychologists believe it is far more important to promote positive attitudes in students than to ensure that they master verbal information, intellectual skills, cognitive strategies, or motor skills.

There are four approaches for ensuring that the students learned appropriate attitude and for changing inappropriate attitudes to more constructive ones: (a) the behaviourist (traditional) approach, (b) the cognitive approach, (c) the social influence approach, and (d) the structural approach.

According to traditional approaches the attitudes are formed, developed, or maintained through the processes of associationism or reinforcement. This approach neglect key points like that attitudes are largely composed of meanings.

According to cognitive approach, attitudes are organized into cognitive structures according to content and meaning. And there is an internal pressure for such cognitive structures to be internally consistent and some what simplified so that there is an overall
good “gestalt.” During childhood and adolescence, students continually reorganize their self-attitude into more differentiated and integrated identities. This reorganization leads to a simple and uniform view of them.

Development of proper scientific attitude is one of the major objectives of teaching physics. Kumar (1995), thought that the development of scientific attitude makes pupil open minded, helps him to make critical observations, develop in him intellectual honesty, curiosity, and unbiased impartial thinking.

According to the New Encyclopedia Britannica (1987), “attitudes logically are hypothetical constructs (i.e. they are inferred but not objectively observable). They are manifested in conscious experience, verbal reports, and gross behaviour.” A person’s attitudes are his/her consistent ways of anticipating, evaluating and responding to people, ideas, objects and situations”. Garret, E. (1972), describes that an attitude is inner state rather than an overt expression. It is basically a tendency to act. It is a mental “set” or readiness to act and not the act itself.

According to Encyclopedia of Psychology (1984), attitude is usually defined as “a disposition to respond favourably or un-favourably to an object, person, institution or event. It is considered a hypothetical construct, being un-observable; it must be inferred from measurable responses that reflect positive or negative evaluations of the attitude object.” Thus attitude is a tendency to respond positively or negatively to specific activities, events or aspects of physical, social, or cultural environment.

Anderson (1981), identified five common feature of attitudes; emotion, target, direction, intensity, and consistency.

An attitude is an evaluation of someone or something (the target). Evaluation involves knowledge, emotion and experience, not just emotion. It is directed at the target (say attitude towards physics). An attitude may be held strongly and not easily modified. While most people naturally strive for some kind of consistency, nonetheless most people
show considerable areas of inconsistency: for example, scientists may hold very strong attitude relating to the way they work (parts of the scientific attitude) but may fail to apply these at all in, a religious context sense where evidence is often ignored and replaced by assertion and speculation.

Shah (2004) quotes Dunham (1974), that attitudes will affect behaviour, influencing what the learner selects from the environment, how he will react to teachers, the material being used and the other students. This selection and the processing of the input of information, which follow it, are strongly influenced by the instructor’s expectations, attitudes, and concepts.

2.15 Measurement and Development of Scientific Attitude

Many researchers investigated and discussed how attitudes might be measured; many studied attitudes as the outcomes of instruction, context, or experience; a few looked at the influence of attitudes on achievement and performance. Although many felt that attitudes were ascertainable, for many centuries it was thought that attitudes could not be measured. It was around 1929 when the first serious attempt was made, to be followed by the work of a researcher called Likert who has given his name to a technique which is widely used today. In this research study the researcher used this technique to measure the scientific attitude of the students.

http://dbweb.liv.ac.uk/tsnpsc/quides/PedagogResearch/GettingStarted.

According to the Encyclopedia of Psychology (1984), “The most prominent feature of an attitude is its evaluative character, the disposition to respond toward an ‘object’ in a positive or negative manner. Attitudes can thus range from very favourable to very unfavourable on an evaluative continuum.”

In an educational setting, there are three ways to measure performance: by means of written test, interview or observation of behaviour. It is the same with attitudes. However, the main two ways are written tests (attitudes questionnaire/ scales/ surveys) and interviews.
Thorndike (1982) has identified five suggestions for writing clear and unambiguous statements/items. These are listed below.

a) Ensure that each item involves feeling and affect and not belief or a statement of fact.
b) Keep the language of the statements simple, clear, and direct.
c) Each statement should contain only one complete thought.
d) Avoid the use of statements that involve double negatives.
e) Avoid the use of words that are vague or words that may not be understood by those who are asked to respond to the scale.

Likert tests are the commonest form of attitude measure used in science teaching. Once attitude measures have been developed and administered, the technical quality of the data must be examined. According to the International Encyclopedia of Education (1994), “The predominant aspects of the technical quality of these measures are: (1) Reliability of attitude measures (2) External validity of attitude measures, (3) The distribution of scores.”

All aspects of physics learning can contribute to attitudes towards physics, to the learning of physics, and development of the scientific attitude. There will be the cognitive aspects: what the learner knows and experiences, and understands. There will be affective aspect: does the learner like experience of the learning, the subject itself and the teacher, the courage to write and speak truth, the development of intellectual honesty and unbiased thinking. There will also be the action component in the sense of what the learner actually does (and this will include practical work i.e. experimentation) and how the learner might use the physics learned.

Carin and Sund (1989), state that scientists have adopted these attitudes as their rules for conducting scientific investigations: (a) Curiosity, (b) Humility, (c) Skepticism, (d) Open mindedness, (e) Objectivity, (f) Positive approach to failure, (g) Avoidance of dogmatism or gullibility.
Reid (2002) doesn’t believe that scientists have adopted the attitudes (as their rule for conducting investigations) which are presented by Carin and Sund (1989). He says that some have, and some have not.

Kumar (1995) agreed that there are numbers of ways for developing scientific attitude among the pupils:

1) Making use of planned exercises.
2) Wide readings.
3) Proper use of practical periods (effective and efficient use of the laboratory).
4) Personal examples of the teacher.
5) Study of superstitions.
6) Co-curricular activities in science.
7) Atmosphere of the class.

The list of seven ways of developing attitude by Kumar is looking inadequate. For example, the planned exercise. It is now well known what kind of exercise is effective and what is not in relation to attitude in general. Reading will not, of itself, necessarily bring about change-this has been studied. However, the nature of the lab-work will have to change quite dramatically and it may prove impossible. Teacher examples is important but how do we achieve that?

In the opinion of Kumar (1995), “scientific attitude may be developed either by direct teaching in the classroom and laboratory or by out of school experiences gained by the students.”

Skinner (1968), used many practical applications of his ‘operant conditioning techniques’ in his teaching. These methods are also likely to be successful, he has argued, in the laboratory. Kuhn (1972) says, “In designing a laboratory course, if we keep an eye on the students’ successes and the way in which they are spaced, we are more likely to
produce a student, who not only knows how to conduct experiments but shows an uncontrollable desire to do so."

Education is concerned with the changing of attitude. Without change in attitude, there can be no education. We can not mean that we aim to prescribe attitude. We can say that the social engineering is at best and brainwashing at worst. He says that good education seeks to enable the learners to develop their own attitudes on a sound cognitive base. He would go further to suggest that an attitude with an inadequate cognitive base is really a prejudice.

Halloran (1967) in Shah (2004), indicated that attitude change depends upon several factors. Three of the most important of these are;

i. The perception of the person presenting the information by those receiving it;
ii. The form in which the information is given;
iii. The characteristics of the people who are receiving the information.

In order to develop scientific attitude among the students, the traditional teaching strategies and the recent Ausubelian approach should be studied thoroughly.

2.16 Scaling

Scaling techniques are used to measure attitude, judgments, opinions and other traits not easily measured by test or other measurement techniques. A number of scaling techniques have been developed over the years.

Gay (1987) states that there are four basic types of scales used to measure attitude;

(1) **Likert scale** (ask an individual to respond to a series of statements by indicating whether he/she strongly agree (SA), Agree (A), is undecided (U), disagree (D), or strongly disagree (DA) with each statement).
(2) **Semantic differential scale** (ask an individual to give a qualitative rating to the subject of the attitude on a number of bipolar adjective such as good-bad, fair-unfair, friendly-unfriendly etc. Semantic differential scales usually have 5 to 7 intervals with a neutral attitude being assigned a score value 0).

(3) **Thurston scale** (ask an individual to select from a list of statements that represent different points of view those with which he or she is in agreement. Each item has an associated point value between 1 and 11; point values for each item are determined by averaging the values of the items assigned by a number of “judges”).

(4) **Guttmann scale** (ask the individuals to agree or disagree with a number of statements. It attempts to determine whether an attitude is unidimensional, i.e. it produces a cumulative scale. In a cumulative, an individual who agrees with a given statement also agrees with all related preceding statements).

http://ndundam.people.cofc.edu/EDFSSPRG2003/EDFS635/Chap5.doc

**Rating Scales** (also used to measure attitudes towards others. Such scales ask an individual to rate another individual on a number of behavioral dimensions. There are two basic types of such rating scales. One type is composed of items that ask an individual to rate another on a continuum (good to bad, excellent to poor). The second type asks the individual to rate another on a number of items by selecting the most appropriate response category (e.g., excellent, above average, average, below average, poor). Two problems associated with rating scales are referred to as the “halo effect” and the “generosity error”.

According to Journal of Enterprising Communities (2009), “Likert scales are sometimes called summated rated scale. Each item is assumed to represent a different aspect, but to possess the same quantity or magnitude, of the trait. Furthermore it is assumed that each item represents the construct being measured. Likert-scale items consist of a statement or characteristic towards which the respondent indicates degrees of intensity.”
On the Likert type items the respondent uses the following scale:
(a) Strongly agree (b) Agree (c) Undecided (d) Disagree (e) Strongly disagree
Responses on each item would then be quantified by assigning a value of 5 to “strongly agree,” 4 to “agree,” 3 to “undecided,” 2 to “disagree,” and 1 to “strongly disagree.” The responses would be summed (and possibly averaged). In the view of Mason & Bramble, (1997), “If each item is written so that higher scores reflect more positive attitudes, then the higher the total or average, the more positive the attitude.”

Likert scales are commonly used in educational and behavioural research. They allow for assessing differences in degree or intensity on a trait and are less difficult to construct than some other kind of scales.

2.17 The Construction of Attitudinal Items

Developing a good questionnaire is an art and it takes a good deal of practice to achieve good results. Reid, (2002) and Shah (2004) identified a set of procedures which can help to develop a better questionnaire.

a) Write down as precisely as possible what you are trying to find out;
b) Decide what types of questions would be helpful;
c) Be creative and write down as many ideas for questions as you can;
d) Select what seem the most appropriate from your list-keep more than you need;
e) Keep the English simple and straightforward, avoid double negatives, keep negatives to a reasonable number, look for ambiguities, watch for double questions;
f) Find a critical friend to comment on your suggested questions;
g) Pick the best, most appropriate and relevant questions, thinking of time available;
h) Layout everything!
i) Try your questionnaire on a small sample of students (e.g. a tutorial group) – ask for comments, criticisms, check time required.
j) Make modifications and only then apply to larger group;
k) Analyse each question on its own

Remember, even with all that, you will almost certainly find one or two questions which are flawed in some way. Perfect questionnaires are a virtual impossibility. The procedure can be summarized as shown in the figure below.

Figure 2.4  Summary of instruction, for the development of questionnaire

Source: Shah (2004, p. 85)

2.18 Knowledge Construction Tools

Based on Ausubel’s theory of learning, Novak and Gowin (1984) invented two tools, concept mapping and Vee mapping, as visual lenses in which to promote new knowledge production and understanding. Thus, a concept map is a visual representation of a major concept subsuming one or more subsidiary concepts. For example, a “mixture-major concept” may be either “homogeneous-subsidiary” or “heterogeneous-subsidiary,” following a hierarchy of knowledge construction. Further, Vee-diagramming incorporates
a concept map into the development of a plan for scientific inquiry. Usually knowledge structures are hierarchical. Vee-diagramming shows how scientists’ conceptual knowledge may be used as a lens to view our scientific inquiry.

In the last few years, much work has focused on the use of concept mapping and Vee diagramming as valuable tools for teachers to help organize and plan science teaching and learning. Teachers consider these strategies successful contributions to developing effective and meaningful teaching and learning, exploring children’s conceptions, developing common knowledge through laboratory work, and assessing children’s conceptions. Novak and Gowin (1984) claim that concept mapping and Vee diagramming help teachers and students to construct new and more meanings of science concepts and principles.

2.19 Concept Mapping

The conceptual (theoretical) foundation of concept mapping is Ausubel’s theory of learning, which tells us that “meaningful learning depends on integrating new information in a cognitive structure laid down during previous learning.”

Concepts are an invention of the human mind, ways of organizing the world. Novak (1991) has defined concept as “a perceived regularity in events or objects, or records of events or objects, designated by a label.” Pines (1985) call them “the furniture of the conscious mind” and he likens words to conceptual handles that enable people to grasp concepts and manipulate them.

According to Ebenezer and Conneor (1998), “A concepts map is thus a semantic network showing the relationships among concepts in a hierarchical fashion. Concepts or ideas are linked with phrases that illustrate the relationships among them.” How can one construct concept maps? A modified version of Leith’s (1988) concept mapping activity sequence for teachers follows.
Concept maps can represent ideas about any topic. They are representations of interrelated concepts and provide a visual image of how the brain connects ideas. A simple concept map is illustrated in Figure 2.5

*Figure 2.5* pictorial concept map of a simple circuit

![Concept Map](image)


Novak and Gowin (1984), have developed a theory of instruction that is based on Ausubel’s meaningful learning principles that incorporates “concept maps” to represent meaningful relationships between concepts and preposition. According to them “a cognitive map is a kind of visual road map showing some of the pathways we may take to connect meanings of concepts.”

In the opinion of Nowak (1991), “concept maps serve to clarify links between new and old knowledge and force the learner to externalize those links. Concept maps are useful tools to help students learn about their knowledge structure and the process of knowledge construction (meta-knowledge). In this way, concept maps also help the student learn, how to learn (meta-learning). Concept mapping requires the learner to operate at all six levels of Bloom’s educational objectives.”
According to Nowak and Gowin, (1984) “concept maps can make clear to the student (and the instructor for curriculum development purposes) how small the number of truly important concepts they have to learn. Concept maps externalize a person’s knowledge structure then concept maps can serve to point out any conceptual misconceptions, the person may have concerning the knowledge structure. This explicit evaluation of knowledge and subsequent recognition of misconceptions allows for finely targeted remediation. Since concept maps are visual images therefore they tend to be more easily remembered than text.”

Lambiotte and Dansereau (1991), state, “the students who viewed or made concept maps would have a broader knowledge base and therefore be more able to solve problems compared to those students who learned by rote memorization. They also found that the students with low prior knowledge learned better with concept mapping than the other two linear presentations.”

Science teacher can use concept maps to determine the nature of students’ existing ideas, and make evident the key concepts to be learned and suggest linkages between the new information to be learned and what the student already knows.

“Cognitive structure and concept mapping are highly personal as each individual’s knowledge is unique. Hence, concept maps are idiosyncratic. There is no one “correct” concept map. However, this does not mean that all concept maps are correct: it is possible to identify errors, such as the absence of essential concepts or inappropriate relationship between concepts.”

http://medinfo.ufl.edu/omi/docs/suter/learn.htm

2.19.1 Concept Mapping for Teachers

If teachers learn how to construct concept maps and use them for planning and assessing lessons, they will be able to teach students better how to make concept maps to organize their thoughts and ideas. Concept mapping is probably done better first in groups so that pre-service teachers can interact with each other. Group members can then
compare and debate the construction of their concept maps and subsequently compare their maps with those of other groups. Finally, individuals should construct and present their own concepts map for a science lesson.

Figure 2.6 A simple concept map on static electricity


Ebenezer and Connor (1998), produced a list to construct a concept map
1. Choose a passage from a science textbook.
2. Circle or underline the main concepts in this passage.
3. List all the concepts on paper.
4. Write or print the concepts on small cards or stickers so that the concepts can be moved around. If you prefer to use a computer-based semantic network, use

5. Place the most general or all-inclusive concept on the top of the paper.

6. Arrange the concepts from top to bottom (from most general at the top to most specific at the bottom) so that a hierarchy is indicated. In constructing this hierarchy, place concepts next to each other horizontally if they are considered to have equal importance or value.

7. Relate concepts by positioning linking verbs and connecting words on directional arrows. Support the concepts with examples.

8. Have members of a cooperative group critically analyze the concept map to improve on and further extend your ideas.

2.19.2 Concept Mapping for Students

Concept maps can help student’s related concepts they bring to the classroom or have learned from instruction. Students may know isolated concepts but not how they relate to each other. Students may write paragraphs about concepts but still not show that they understand how the concepts are interrelated. Concept mapping is a powerful strategy used across the curriculum that can help teach children the structure and meanings underlying a topic.

As soon as children can read, they can work with simple concept maps. Even before children can read, they can use picture concepts (Kilshaw, 1990; Cross, 1992). Kilshaw presented her 6- and 7-year old children with lists of words connected with the concept of plant growth after playing a word association game. She relates that the children worked on their own, beginning by copying the words on a sheet of paper. Then they were encouraged to draw arrows connecting the words and write other words to explain the connections. Kilshaw concluded that concept maps were an excellent tool for assessment but must be used in conjunction with discussion and questioning of children’s understanding. Cross used picture cards instead of words, finding these more satisfactory for teaching his 5-, 6-, and 7-year-old children about electric circuits.
Ebenezer and Connor (1998), state that concept maps can be constructed in the classroom using three different approaches:

- Students construct the maps using concept words supplied by the teacher.
- Students construct the maps identifying the concepts from an information source.
- Students construct the maps from their own personal knowledge.

### 2.20 Learning

Learning involves many skills and experiences, which are possible in science classroom and laboratory situation. The simplest form of learning is imitation that is producing things as a copy of the real one. In the views of Shah (2004), imitation is useful form of learning especially in the laboratory situation. It encourages one to grow and pretend freely without risk of being wrong or embarrassed.

Learning may be more formally defined as a relatively permanent change in the potential behaviour resulting from experience. Bigge (1982), stated that learning in contrast with maturation, is an enduring change in a living individual that is not heralded by his genetic inhabitance. It may be considered a change in insight, behaviour, perception or motivation or a combination of these. Gagne (1975) observes that “learning is a change in human disposition or capabilities, which can be retained, and which is not simply ascribable to the process of growth.”

Smith (1993) writes that “the term learning defines precise definition because it is put to multiple uses: (1) The acquisition and mastery of what is already known about something, (2) the extension and clarification of meanings of one’s experience or (3) an organized, intentional process of testing ideas relevant to problem.”

It is used to describe a product (the emphasis is on the outcomes of the experience), a process (the emphasis is on what happens when a learning experience takes place), and a function (the emphasis is on certain important aspect like motivation which help product learning).
Learning outcomes are what the students attain from the course. Commonly in science classroom or laboratory courses, the learning outcomes, which are tested, are those, which are the easiest to measure by pencil-and-paper tests. Greater emphasis is placed upon students’ ability to describe experimentation rather than upon their experimental skills, on the production of ‘right answers’ than on critical thinking, on correct conduct of experiments rather than experimental design or planning.

Gagne (1978) developed a model which has two postulates (i) Images, which are figural representation in memory of diagrams, and pictures. These have a great potential for building up this type of memory when the physics teacher demonstrates in the lab. (ii) Episodes, which are representations in the memory of the past events in which the individual was personally involved. Both images and episodes are powerful aids to the recall of any knowledge associated with the students.

According to Shah (2004), two main concepts are involved in learning practical tasks, knowledge and skills. Knowledge involves memory for symbolic material such as words, number, and diagram, and is said to be learned when it is memorized and appropriately recalled. Skills involve non-symbolic information, which must be acquired through motor and perceptual learning. In physics laboratories this can be thought of in terms of Physics to be learned and practical skills, which should be mastered. This kind of analysis is of limited use in that case it ignores attitude, and important thinking skills like creativity and critical thinking.

Pazzani (1991), in Shah (2004) suggested that the ability to memorize the name of different components is due to some prior knowledge about these components. However, if we have no previous knowledge about these components, the learning will be poorer. This suggests that, if the students have some ideas or some knowledge before the laboratory work, their understanding and performance will be good. In other words, their learning will be better as compared to the students who have no pre-knowledge; this supports the notion of some kind of pre-lab work. Gagne (1985) in shah (2004), describes that skills should be learned one at a time in order to build on previous information.
According to Kolb’s learning theory (1984), the concrete concepts must be mastered and then extended to the abstract. So we can say that the learning will be more distinguished if the concepts, ideas or information are logically and psychologically arranged. This favours the idea of “concept mapping”. Within cognitive field theory, learning is a relativistic process by which a learner develops new insights or changes old one. In no sense is learning a mechanist atomistic process of connecting stimuli and responses within a biological organism.

Learning is the modification of the person’s world as represented by the model (life space- the psychological model). Kumar (1995), expresses his views that the “different curriculum standards reveal a common spirit over and over again, these professional organizations admonish traditional models of education for emphasizing memorization, and usefully to cover content at the expense of deep conceptual understanding.”

According to Crow and Crow (1963), learning involves change which is concerned with the acquisition of habits, knowledge and attitudes. The sense of learning according to Gagne (1977) is simply the development of capabilities that are the outcomes of learning. These include: a) verbal information (b) Intellectual skills (c) Cognitive Strategies (d) Attitude (e) Motor Skills.

The concept of change is inherent in the concept of learning. Learning that occurs during the process of change can be referred to as the “Learning process”. Psychologists have developed several theories, which explain the phenomenon of learning from several viewpoints. Unfortunately, there is no single learning theory, which is by itself relevant to the entire school curriculum. However, the information processing model which I presented in figure 1.1 brings together most of the models in the literature into a coherent whole. It has been found to describe all learning very well and, even more importantly, is powerfully predictive. Thus, the model predicted the power of pre-learning which the researcher used in pre-labs but the literature also has pre-lectures and there predicted
power clearly shown. It predicts the rate-determining control of the limited capacity of working memory. If any task needs more space than is available in working memory, then the task is more or less impossible (Johnstone & El-Bana, 1989). If the task is reorganized so that working memory load is less likely, then performance increases quite dramatically (Reid, 2004).

Shah (2004) expresses the views of North Central Regional Education Laboratory (NCREL) that “the different curriculum standards reveal a common spirit. Over and over again, these professional organizations admonish traditional models of education for emphasizing memorization and usefully to cover content at the expense of deep conceptual understanding.”

Alavi, Maryam (1994), explained the theory of learning as;

“Tell me and I will surely forget.
Show me and I might remember.
But make me do it, and I will certainly understand.”

There are also many factors, which influence learning in one way or another. Vadidya, (1996) mentioned these factors as: (1) Motivation (2) Interests and attitudes (3) Poor communication (4) Remembering and forgetting (5) Difficulty of teaching material (6) Teaching and learning strategies.

Learning is not a passive absorption of learning material (rote learning) but active mental process (meaningful learning). In the view of Zaman (1996), “Learning is a flow of information from perception filter to working memory space here it reshapes and organizes according to the pre-knowledge exists in the cognitive structure of the individual and then it goes into the long term memory in the form of chunks for further retrieval”. School learning cannot take place in the absence of considerable mental processing activity, conscious and deliberate or otherwise, on the part of the person who learns. Learning always involves (mental) doing. Smith (1993) expressed the views that “when we go about activities such as working, playing and learning, we use our mind and
our senses in consistent ways, we have acquired preferred patterns of perceiving, remembering, thinking and problem solving. Complex cognitive strategies are, structure, and control is at working that enables us to deal successfully with the stimuli that come our way.”

It is difficult to summarize learning in a single phrase or sentence, which will encompass all situations. Here learning will be seen as active, goal directed construction of meaning. Learning involves experience that will change the behaviour and attitude. Bigge (1982), provides the simplest grouping, classifying theories into one of the two families:

(1) Stimulus-Response (S-R) conditional theories of the behaviorist family and,
(2) Cognitive theories of the Gestalt-field family.

This simple dichotomy summarizes two ways instructional designs have traditionally viewed the learner: learner as doer and learner as thinker.

Merriam and Caffarella (1991) classify learning theories into four orientations: “(1) behaviorist, (2) cognitive, (3) humanist, and (4) social learning.”

Romiszowski (1986), proposes a similar model, but uses the following categories: “behaviorist, cognitive, developmental, humanist, and cybernetic.”

The table shown below builds on a table from Merriam and Caffarella to include Romiszowski’s cybernetic orientation, and also expanded Merriam and Caffarella category of social learning to include situated learning as well.
Table 2.1  
*Five Orientations to Learning Theories*

<table>
<thead>
<tr>
<th>Theorists</th>
<th>Behaviourist</th>
<th>Cognitivist</th>
<th>Humanist</th>
<th>Social/Situated Learning</th>
<th>Cybernetic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Thorndike,</td>
<td>Koffka,</td>
<td>Rousseau</td>
<td>Bandura, Rotter, Vigotsky,</td>
<td>Weiner,</td>
</tr>
<tr>
<td></td>
<td>Pavlov,</td>
<td>Kohler,</td>
<td>Pestalozzi,</td>
<td>Brown, Argyris, Lave and</td>
<td>Shannon,</td>
</tr>
<tr>
<td></td>
<td>Watson,</td>
<td>Wertheimer,</td>
<td>Froebel,</td>
<td>Wenger, Brandsford,</td>
<td>Miller,</td>
</tr>
<tr>
<td></td>
<td>Guthrie,</td>
<td>Lewin,</td>
<td>Neill,</td>
<td>Collins &amp; Duguid.</td>
<td>Gibson,</td>
</tr>
<tr>
<td></td>
<td>Hull,</td>
<td>Reigeluth,</td>
<td>Rogers and</td>
<td></td>
<td>Landa,</td>
</tr>
<tr>
<td></td>
<td>Tolman,</td>
<td>Piaget,</td>
<td>Maslow.</td>
<td></td>
<td>Pask.</td>
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<tr>
<td></td>
<td>And Skinner.</td>
<td>Ausubel,</td>
<td></td>
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<td></td>
<td></td>
<td>Bruner,</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Gagne.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Views of the learning process</td>
<td>Change in behaviour.</td>
<td>Defined by Internal mental process (Including insight, perception, information processing, and memory.)</td>
<td>A personal Act to fulfill potential.</td>
<td>Interaction with and observation of others in a social context.</td>
<td>Systemic and defined by capacities of memory, throughput, and feedback loops. Learner is ‘wired’ into the environment</td>
</tr>
<tr>
<td>Purpose of instruction</td>
<td>Produce Behavioural Change in desired Direction.</td>
<td>Develop capacity and skills to learn better.</td>
<td>Become self-actualized, Autonomous</td>
<td>Model new Roles and behaviour.</td>
<td>Develop the learner as ‘information processor’.</td>
</tr>
<tr>
<td>Role of the Designer</td>
<td>Design stimuli to elicit desired response.</td>
<td>Structure content of learning activity. Meaningful and logical arrangement of contents.</td>
<td>Facilitate development Of the whole person.</td>
<td>Present models of new roles and behaviours.</td>
<td>Design Systems that accept student inputs and provide meaningful feedback.</td>
</tr>
</tbody>
</table>

Source: [http://chiron.valdosta.edu/whuitt/col/cogsy/infoproc.html](http://chiron.valdosta.edu/whuitt/col/cogsy/infoproc.html)
2.21 Information Processing Theory of Learning

The historical roots of the cognitive approach to learning lie in the gestalt and field theory of Psychology. In the view of Johnson (1979), “the most promising contemporary cognitive theory of learning is that of information processing, which divides, learning into three phases: (1) attending to new information (2) acquiring and retaining information, and (3) retrieving information from memory and transferring it to new situation.”

The way that information is processed in learning has been summarized in the model proposed by Johnstone (1993), Johnstone and Elbana (1994). This model is shown in figure 1.1 in chapter one.

According to this model the learner is seen to view new events, observation and instructions through perception filter, which is influenced by what is already stored in the long-term memory. In this way, the learner selects and interprets new information in terms of what he/she already knows. This model has been found to be very useful in teaching and learning science in the classroom and laboratory. This model focuses on learning and the learner, and suggests mechanisms in the learning process. It includes the ideas of Ausubel.
### Table 2.2 Using the Information Processing Approach in the Classroom

<table>
<thead>
<tr>
<th>Principle</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Gain the students’ attention.</td>
<td>Use cues to signal when you are ready to begin. Move around the room and use voice inflections.</td>
</tr>
<tr>
<td>2. Bring to mind relevant prior learning.</td>
<td>Review previous day's lesson.</td>
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<td></td>
<td>Have a discussion about previously covered content.</td>
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<tr>
<td>3. Point out important organized manner.</td>
<td>Provide handouts.</td>
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<td></td>
<td>Write on the board or use transparencies.</td>
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<tr>
<td>4. Present information in an organized manner.</td>
<td>Show a logical sequence to concepts and skills.</td>
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<tr>
<td></td>
<td>Go from simple to complex when presenting new material.</td>
</tr>
<tr>
<td>5. Show students how to categorize related information.</td>
<td>Present information in categories.</td>
</tr>
<tr>
<td></td>
<td>Teaching inductive reasoning.</td>
</tr>
<tr>
<td>6. Provide opportunities for students to elaborate on new information.</td>
<td>Connect new information to something already known. Adam</td>
</tr>
<tr>
<td></td>
<td>Look for similarities and differences among concepts.</td>
</tr>
<tr>
<td>7. Show students how to use coding when memorizing lists.</td>
<td>Make up silly sentence with first letter of each word in the list.</td>
</tr>
<tr>
<td></td>
<td>Use mental imagery techniques such as the keyword method.</td>
</tr>
<tr>
<td>8. Provide for repetition of learning.</td>
<td>State important principles several times in different ways during presentation of information (STM).</td>
</tr>
<tr>
<td></td>
<td>Have items on each day’s lesson from previous lesson (LTM). Adam</td>
</tr>
<tr>
<td></td>
<td>Schedule periodic reviews of previously learned concepts and skills (LTM).</td>
</tr>
<tr>
<td>9. Provide opportunities for over learning of fundamental concepts and skills.</td>
<td>Use daily drills for arithmetic facts. Play form of trivial pursuit with content related to class.</td>
</tr>
</tbody>
</table>

**Source:** [http://chiron.valdosta.edu/whuitt/col/cogsy/infoproc.html](http://chiron.valdosta.edu/whuitt/col/cogsy/infoproc.html)
For understanding to occur, the working memory has to be involved. The long term memory is simply a store. Working memory is where a person thinks, understands, problem solves and so on. The capacity of working memory can be measured easily and is found to lie, for those over 16 between 5 and 9. If any learning task requires more space, that task becomes impossible. This explains all learning difficulties in physics and, when teaching takes account of this key learning limitation, then understanding is greatly enhanced. Indeed, it turns impossibility into possibility.

2.22 The Geneva School (Jean Piaget)

Piaget and Inhelder (1969), in Vadidya (1996) have identified scientific stages of cognitive development through which they believe each child normally passes before being capable of abstract or formal thinking.

Piaget is fundamentally a genetic epistemologist and therefore engaged himself in studying how human mind develops ideas about the environment. Specifically, he studied changes in knowledge and interpreted them from the psychological point of view by studying children. He believes that children are eager to learn and are active in their own development. This development takes place in four stages. He further said that cognitive development depends upon four factors (1) Maturation (2) Experience (practice, physical, logical, and mathematical) (3) Social environment (4) Equilibrium. Each will be now discussed below.

Maturation is an important concept, which is not independent of learning. It simply places restriction on what kinds of behaviour are possible at various ages. It indicates a sequence of growth; infancy, childhood, adolescence and adulthood. Piaget then distinguished among three types of experiences; physical exercise, logical and mathematical. Exercise/practice leads to the refinement of the experience. A child acts on things and objects. He learns to compare, contrast, discriminate, transfer and thereby, begins to form concepts. If physical appearance becomes deceptive, the child overcomes this deficiency by developing in terms of logical operations/schemes of thought.
A child lives in a society. As he grows, he knows gradually that there are viewpoints other than his own. For Piaget, action rather than language is the basis of all knowledge.

*Figure 2.7* Importance of few major factors in cognitive development

Equilibrium is the most important factor, which describes the gradual evolution of thought in logical terms from stage, which is hierarchically determined. It means that the succeeding stage controls all the stages preceding it.

The content of the earlier stage becomes the form of the succeeding stage and vice versa. There is disequilibrium when equilibrium at any point is disturbed. The system must obtain equilibrium at higher level. The ensuring contradictions or inner conflicts are then set right or resolved. Thus, this cycle continues to spiral where concepts get
repeatedly reviewed but each at a higher level. The process is therefore self-adjusting, providing a dynamic meaning to our understanding of the world. (Vadidya, 1996)

Piaget (1964) stressed the following aims of education:

(a) To create men who are capable of doing new things, not simply repeating what other generation have done. Education should create men who are creators, inventors and discoverers.

(b) To develop minds which can be critical, can verify and do not accept everything they are offered (negate rote learning).

2.22.1 Piaget’s Theory of (Intellectual) Cognitive Development

Piaget asserts that learning is a function of development. He claims that cognitive development, intellectual development and development of intelligence are more or less synonymous.

Piaget’s theory of intellectual development has two components, one cognitive and other affective. Piaget (1964) saw cognitive acts as “acts of organization and adaptation to the environment.” Piaget asserted that, “the basic principles of cognitive development are the same as that of biological development. From the biological point of view, organization is inseparable from adaptation; these are the complementary processes of a single mechanism, the first being the internal aspect of the cycle and adaptation constitutes the external aspect.” For Piaget “intellectual activity could not be separated from the “total” functioning of the organism.”

The process responsible for cognitive development is assimilation and accommodation. In the process of assimilation which is the cognitive process, the individual integrates new knowledge (factual, conceptual, procedural, motor) into existing knowledge or schemata or patterns of behaviour. When a child confronted with a new stimulus, he can create a new schema into which he can place the stimulus or he can modify an existing schema so that the stimulus will fit into it.
Accommodation involves modification or change in some elements of an old scheme or learning a new scheme, which is more appropriate for the new object.

Accommodation accounts for development (a qualitative change), and assimilation accounts for growth (a quantitative change); together they account for intellectual adaptation and the development of cognitive structures.

In the view of Siann and Denis (1985), “learning takes place through the interaction of ‘assimilation’ and ‘accommodation’. An intelligent behaviour requires a balance between assimilation and accommodation, and is called equilibrium.” According to Piaget (1964), “a state of ‘equilibration’ between assimilation and accommodation is as necessary as the process itself. Equilibrium is a self-regulatory mechanism necessary to ensure the developing child’s efficient interaction with the environment.” Piaget viewed cognitive development as “having three components: content, function, and structure.” For Piaget, “all knowledge is physical knowledge, logical-mathematical knowledge, or social knowledge.” For conceptualizing cognitive growth, Piaget (1969), divided intellectual development into four broad stages. Long periods of development can be subdivided into periods of shorter lengths to analyse and conceptualize development more efficiently.

Gupta (1995) believed that each child normally passes through these scientific stages of cognitive development before being capable of abstract or formal thinking. These stages with examples of behaviours associated with each stage are as under:

1. **The stage of sensory motor intelligence (Aspects of sensory motor stage: 0-2 years)**
   
i. Mainly directed by stimuli outside the mind. (Stimulus-bound and unable to initiate thought)
   
ii. Pre-verbal (no language).
   
iii. Thought proceeds from action.
iv. Learns to perceive and identify objects.
v. By the end of the period child distinguishes parents, animals, and knows names.
vi. Rudimentary sense of direction and purpose appears late in stage.
vii. Time (present-and limited to the duration of their actions.)
viii. Space (immediate – and is limited to the area in which children act.)

2. The stage of pre-operational thought (Aspect of pre-operational stage: 2-7 years)

i. Performs operations-combining, separating, grouping, ordering, seriating, multiplying, dividing, substituting, and reversible thinking.
ii. Analyses.
iii. Aware of variables.
iv. Classifies. (The child develops classification ability).
v. Limited hypotheses are possible.
vi. Understanding of space and time are greatly expanded.
vii. The child develops conservation ability.
viii. Measures.
ix. The child develops the ability to apply logical thought to concrete problem.

3. The stage of concrete operations (Aspects of concrete operational stage: 7-11 years)

i. Performs operations - combining, separating, grouping, ordering, seriating, multiplying, dividing, substituting, and reversible thinking.
ii. Analysis
iii. Aware of variables.
iv. Classifies.
v. Limited hypotheses are possible.
vi. Understanding of space and time are greatly expanded.
vii. Measures.
viii. The child develops conservation ability.
ix. The child develops the ability to apply logical thought to concrete problem.

4. **The stage of formal operation (formal operational stage: 11-15)**

i. Performs hypothetical and prepositional thought.

ii. The child develops abstract and reflective thinking (evaluates his thinking process).

iii. Synthesizes.

iv. The child controls variables.

v. Understands probability.

vi. Does ratios, proportions and combinational logic.

vii. Imagines.

The child’s cognitive structures reach their greatest level of development and the child becomes able to apply logical reasoning to all classes of problem (Gupta, 1995).

*Figure 2.8*  
Piaget’s four stages of mental development

The chronological ages during which children can be expected to develop behaviour representative of a particular stage are not fixed. The age spans suggested by Piaget are normative and denote the time during which a typical or average child can be expected to display the intellectual behaviours that are characteristic of the particular stage. “The age at which the stages occur can vary with the nature of both an individual’s experience and his or her heredity.” Progress through stages is not automatic. One aspect of Piaget’s theory, which is ‘fixed’, however, is that “every child must pass through the stages of cognitive development in the same order.” Nevertheless, the rates at which children pass through the stages may not be identical because of experiential or heredity factors. Piaget (1969), suggested that there are four broad factors that are related to all cognitive development;

(1) Maturation,

(2) Active experience,

(3) Social interaction, and,

(4) A general progression of equilibrium.

Developmental psychology of Piaget is being used today to identify objectives and learning experiences in terms of developmental stages. Gupta (1995), quotes Piaget’s view that rote-memorization does not produce new mental structure, because it does not involve comparing, correlating or inter-relating new information with existing mental structures.

Teachers must understand that Piaget is primarily concerned with a level of knowing and functioning that goes beyond memorized facts or skills. Gupta (1995), states; “To engage students in activities, requiring logical thinking, teacher must devote class time to investigations which are not prescribed and in which the end point is not pre-determined. Investigations should be true experiments, which allow students to control variables, collect data and draw conclusions. Obtaining an answer from a text book or an expert is not allowed.” He further goes on to say that teacher should try to let a child develop and do investigation by himself. Too often, the help of a well-intentioned teacher causes a child to miss most of the learning opportunities in the experiment. Let
students commit errors and rectify them themselves. A vital role is to provide encouragement, overcome frustrations and develop confidence in students.

2.22.2 Cautions for teachers using Piaget’s four stages:

Carin and Sund (1989), state that it is very important for the elementary / secondary school teachers to note the limitations concerning Piaget’s four stages of cognitive development when working with their students:

a). Stages do not mean distinct, sudden changes in development rather long period of stability followed by abrupt change. Most important changes happen gradually, over months or years.

b). The ages associated with each stage are only averages. Many children in a given age group may not have developed the characteristics indicated for that age.

c). The sequence for passing through the four stages is always the same i.e. no person skips a stage.

d). When children reach each stage they can vary considerably with differences in backgrounds and abilities. Although many children may be slower in neurological and cognitive development, and to be a year or more behind the sequence indicated, does not mean that they will be cognitively inferior in later years to those who develop earlier.

e) Many adults, who should be capable of performing on a formal-operational stage, do not reach this level. (Mentally retarded children also do not reach the formal-operational stage.

Because of wide variations in cognitive development of the children in a class, it is necessary for the teacher to understand Piaget’s four stages of mental development so he can recognize the cognitive differences in the students and interacts with them more appropriately. This is especially important in science, since it plays such a significant role in developing cognitive abilities.
Figure 2.9  
Piaget’s Types of Knowledge

![Diagram showing types of knowledge: Physical Knowledge, Social Knowledge, Logical-Mathematical Knowledge.]


Criticism

1. Piaget’s stage concepts are largely descriptive rather than exploratory, because the conditions that explain or predict a child’s behaviour in a particular stage are not known or specified.

2. The concept of structures has been criticized in that it describes tasks not behaviour.

3. The concept of stages is sometimes not supported empirically.

4. Piaget’s theory has led us to believe that the young child is egocentric, that is, it does not understand another’s point of views. But some physiologists have reported a task in which a child knew something different from his/her mother. He claimed that the two year-olds did not understand the task, the three-year-olds had difficulty with it, the four, the five, and the six year olds behaved non-egocentrically.

5. Psychologists argued that the young children’s powers of reasoning are far greater than of Piaget’s claim.
2.23 Learning by Discovery: Jerome Bruner

Bruner is well known for his essay on “discovery learning” and believed that science should not be taught factually but as a “tool” subject. He does not suggest a recipe for teaching but the way the children learn “how to learn”.

Johnson (1979), states that Bruner influenced educational practice in four ways: through his emphasis on the process of learning, through his notion on the formation of learning structure, through the importance he places on intuition, and through his emphasis intrinsic motivation.

According to Bruner (1996), what is important is not the memorization of facts, but the process of acquiring knowledge. He further goes on to say that learning is a matter of rearranging or transforming evidence. It is a type of thinking in which the student goes beyond the information given to gain new insights and generalizations. The teacher does not tell students the principle, generalization, or rule they are supposed to learn; rather, he or she involves students in a process of induction to discover it.

According to Shah (2004), similar to inquiry, the discovery approach is inductive but differs with respect to the outcome of the instruction and to the procedure followed. In inquiry, the outcome is known to both the teacher and the learner, whereas, in the discovery learning the teacher guides learners towards discovering a desired outcome.

Bruner (1967) states that it is not necessary that students are to discover every bit of information by themselves but they are to discover the inter-relatedness between their post-knowledge and pre-knowledge. It is the duty of the teacher to encourage the students and develop self-confidence, and the ability to learn “how to learn”.

Bruner (1967) thought that “a significant difference could be made to a child’s intellectual development by careful curriculum design and skillful teaching.”

Bruner (1966) suggested that “learning is an active process in which learner construct new ideas and concepts based on their current and / or past knowledge. The
learner selects and transforms information, constructs hypotheses and makes decisions, relying on their cognitive structures. Cognitive structure (schema, mental modals) provides meaning and organization to experiences and allows the individual to go beyond the information given."

Bruner was very much impressed by Piaget’s work and there are similarities between Bruner’s approach and that of Piaget. Both believe that the students can construct knowledge if they are presented with appropriate opportunities to learn. The constructivist perspective is developed from such approaches. However, the constructivist approach has tended to focus on the problem arising from misconstructions rather that on the process by which knowledge and understandings are constructed.

Bruner (1971), contended that “students, starting at early primary school stages, should learn the structure of a body of knowledge instead of items of information which require much memorization.” He also asserts that “students should be taught and encouraged to discover information by themselves.” Snelbecker (1974), says that discovery learning requires that students participate in making many of the decisions about what, how, and when something is to be learned. He further goes on to say that instead of being “told” the content by the teacher, it is expected that the student will have to explore examples and “discover” the rule, principle or concepts which are to be learned. Indeed, discovery learning presupposes a student desire to learn and that it is possible for the teacher to develop learning situation where students can construct their own understandings. In many areas, this may prove to be very difficult. It is unlikely that students can make discoveries in a few hours, which took the best intellects many centuries to develop.

The inductive process of learning mastered by students as they participate in discovery learning situations are aimed at the formation of learning structures, which consist of concepts and coding systems.

Bruner (1966), lists four advantages of emphasizing structure in teaching:
(1). Understanding the fundamental structure of a subject makes it more comprehensible—we understand material better if it is logically organized. (2) A structure permits the students to narrow the gap between elementary and advanced knowledge—if given the appropriate learning experiences, even very young children can understand some of the basic concepts in a subject area. (3) Unless detail is organized into a structured pattern, it is rapidly forgotten—we remember material better, can actually remember more material and are better able to retrieve material from our memory when it is logically organized. (4) An understanding of fundamental principles and ideas facilitates adequate transfer.

Bruner assumes that a student’s interaction with the world always involves categorization or conceptualization. By categorizing, the student reduces the complexity of the environment and by conceptualizing; he or she organizes the concepts into coding system. (A coding system is a structure of concepts that ranges from the very specific to the generic. Generic concepts include more specific concepts).

Bruner (1960), stresses the importance of intuition in learning: He says that memorization of verbal or mathematical information is not an appropriate goal for education. Educational goal should emphasize intuitive understanding of an area, which allows the student to use the ideas in ways that reveal a deep grasp of the area.

An intrinsic motive is one whose reward lies in the activity itself or in the successful termination of the activity. Bruner (1960), states that there are four major intrinsic motives. The teacher can encourage: (1) the will to learn, (2) the inherent drive to cooperate with others, (3) curiosity and the search for clarity, and (4) the drive for competence.

According to Bruner (1967), “any domain of knowledge (Physics, Chemistry, Biology) or any problem or concept within that domain (atomic structure, law of gravitation, viscosity) can be represented in three ways: (1) by a set of actions, (2) by a set of images or graphics that stand for the concept, and (3) by a set of symbolic or logical statements.”
Bruner’s theory refers to the structure of knowledge, he explained that “any idea or problem or body of knowledge can be presented in a form simple enough so that any particular learner can understand it in a recognizable form.”

Bruner ran his own experimental school for investigating the cognitive growth of children. He believes that even abstract concepts can be taught to young children. That is each and every concept can be taught at each and every level but it is fault of the teacher that he/she cannot simplify the concept at that particular level.

*Figure 2.10* Three stages of mental growth as visualized by Bruner

![Diagram](image)

Stages of Mental Growth

Like Piaget, Bruner put forth three kinds of internal representatives, which form a sequence in the growing child. This sequence comprises: (1) Enactive representation, (2) Iconic representation, (3) and, Symbolic representation.

Figure 2.11 Bruner’s Modes of Representation

![Bruner’s Modes of Representation](image)

Source: Vaidya, (1996, p. 175)

Bruner believes that discovery learning allows students to move through these three stages as they encounter new information: the enactive, iconic and, symbolic. This can be thought of as knowing what action to perform, knowing how to represent through internal visual imagery, knowing how to represent by means of a symbol system as in mathematics and language. For an individual to make progress a concept should pass
through each mode in turn, using all three modes together then increased Knowledge and understanding.

Vadidya (1996), states that the first stage of Bruner resembles the sensory motor stage of Piaget (Child executes only motor skills: learning to walk, tying shoe laces or buttoning the shirt). Things are lived rather than thought; action is the basic of thought. So intelligence is basically seen as a scheme of coordinating motor actions.

The second stage is highly perceptual as well as spatial in nature. It covers the inductive and pre-operational stage of Piaget. At this stage, the child tackles reality on the basis of “point-at-table” correspondence. He reacts to sensory motor data around him but is easily distracted. Thus what is needed is the central control over his perceptions, which in turn, control effectively the inputs. He lays stress on imagery, i.e., what does a given label stand for? As soon as this happens, he learns a concept in which common representation is discovered, getting linked to several perceptual objects. The use of imagery at this stage is a positive factor in achievement due to early emphasis on processes like naming, identifying and classifying.

At the third stage, symbolic representation appears which takes into account the internalized overall view. One of its most important expressions is language, which accelerates the acquisition of concepts. Thus we have the following sequence: Action---------Imagery--------Symbol. It corresponds to the Piaget’s concrete stage and is the most advanced form of representation.

Piaget talks about the universal child while Bruner stresses the role of language and culture in the education of children. Both however, agree that a child should be introduced to the “knowledge getting process” as a move towards acquiring active knowledge.

Discovery learning encourages students’ actively to use their intuition, imagination, and creativity. Because this approach starts with the specific and moves to the general, the
teacher presents examples and the students work with examples until they discover inter-relationships.

http://www.duq.edu/~tomei/ed711psy/c_bruner.htm

Bruner (1966) believes, “classroom learning should take place through inductive reasoning, that is, by using specific examples to formulate a general principle.”

2.24 How to Apply Bruner’s Model in the Classroom

- Present examples and non-examples of the concept you are teaching. For example in teaching about mammals, include people, kangaroo, whales, cats as examples and hen, parrot as non-examples.
- Help students see connections among concepts, e.g. Use diagram or matching test items to point out the connection.
- Pose questions and let students try to find the answer, (They start thinking to solve the problem.)
- Encourage students to make intuitive guesses.

To implement this strategy (i.e. discovery learning) the teacher uses a cooperative goal structure, utilizes conflict for a focal point, skillfully questions students, gives students the freedom to inquire, observes, provides a responsive environment for learning, and extends students’ thinking and level of analysis.(Johnson,1979).

Hacker (1984), describes three schools of thought for the intellectual development of the science:

(1) Logical theorists; focusing attention on some form of task analysis, which makes the subject more digestible for the learners. Gagne’s work provides a well-known example of this approach. His ideas are particularly important because of emphasis on prior learning.
(2) Pupil classroom behaviour theorists; stressing the ideas which children bring to the classroom.

(3) Cognitive theorists; emphasizing internal restrictions on the child’s thinking. This school of thought encompasses the Piagetian and Neo-Piagetian paradigms and information processing views of cognitive development with particular emphasis on the work of Ausubel.

The present study is limited to the third school of thought, “the Ausubel meaningful learning views of cognitive development”.

2.25 Learning by Building on Previous Knowledge

Ausubel’s ideas are significantly important in the work reported here because of his emphasis on meaningful learning, it includes pre-knowledge and the knowledge developed in the learner’s cognitive structure.

Ausubel’s cognitive learning theory has been found to be useful guide for learning events. The key concepts involved in the theory are a guide for teachers to improve teaching and learning. According to Ausubel (1967), “Meaningful learning occurs when the learner’s appropriate existing knowledge interacts with the new learning.”

As an educational psychologist, Ausubel was concerned with prior knowledge as a factor influencing learning. And this is the main emphasis of this study reported here that how meaningful learning takes place. According to Ausubel (1978), “the most important factor influencing learning is the quantum, clarity and the logical organization of a learner’s present knowledge. This present knowledge which is available to the learner at any time is referred to as his cognitive structure”. (A cognitive structure consists of stable organization of concepts, facts, rules, theories and the raw perceptual data, arranged hierarchically, with the most generic concept at the apex and increasingly specific concepts toward the base.)
Ausubel (1968) stated that if I had to reduce all of educational psychology to just one principle; “I would say this: the most important single factor influencing learning is what the learner already knows”. Ascertain this and teach him accordingly. Novak (1980) agreed that Ausubel’s theory is applicable and more powerful for teaching science education than the developmental psychology of Piaget.

Both Ausubel and Piaget have offered some key insights for sciences. Forgotten is caused mainly by the connections between the ideas being lost so that the persons can find there way in their long term memory to retrieve the answer they want.

According to Ausubel (1978), “A primary process is learning subsumption in which new material is related to relevant ideas in the existing cognitive structure on a substantive, non-verbatim basis. Cognitive structures represent the residue of all learning experiences; forgetting occurs because certain details get integrate and lose their individual identity.”

According to Arends (2004), the major pedagogical strategy proposed by Ausubel (1963) was the use of advance organizers. It is the job of the organizers to: “Delineate clearly, precisely, and explicitly the principal similarities and differences between the ideas in a new learning passage, on the one hand, and existing related concepts in cognitive structure on the other.”

Ausubel (1963) states, “advance organizers are different from overviews and summaries, which simply emphasise key ideas and presented at the same level of abstraction and generality as the rest of the material. Organisers act as a subsuming bridge between new learning material and existing related ideas.”

According to Shah (2004), “Optimal learning generally occurs when there is a potential fit between the student’s schemas and the material to be learned. To foster this association, Ausubel suggests that the lesson always begin with an advance organizer- an introductory statement of a relationship of high-level concept, broad enough to
encompass all the information that will follow. The function of the advance organizers is to provide scaffolding or support for the new information. It is a conceptual bridge between new material and a student’s current knowledge.

Another instructional tool, which has its basis on Ausubel’s learning theory, called concept map which main purpose is to relate the concepts in logical organization with mega concept at the apex and, serves to clarify links between new and old knowledge and force the learner to externalize those links.

Concept maps and advance organizers are very useful tools to help students learn about their knowledge structure and the process of knowledge construction (meta-knowledge), and help the students learn how to learn (meta-learning).

2.26 Importance of Prior Knowledge

According to Ausubel (1968), “prior knowledge is the most important factor in learning. This means that learning primarily depends on what the learner already knows. He describes meaningful learning (as distinct from rote learning) as; non-arbitrary, substantive, non-verbatim incorporation of new knowledge into a cognitive structure.” He claims that meaningful learning occurs when the learner’s appropriate existing knowledge interacts with the new learning. On the other hand, rote learning of new knowledge occurs when no such interaction take place.”

Ausubel (1968) emphasized that “to learn meaningfully, individuals must relate new knowledge to relevant concepts and proposition they already know. In rote learning, on the other hand, new knowledge may be acquired by memorization.”

Ausubel (1978) clearly indicates that “Depending on the nature of the learner’s existing knowledge and how it interacts with the new knowledge, there will be varying degrees of meaningful learning. Ausubel calls those aspects of existing knowledge that can provide these interactions for meaningful learning, ‘subsumers’. A subsumer is any
concept, principle, idea or generalization that the learner already knows which can provide an anchorage for various components of the new knowledge.”

In Ausubel’s (subsumption) theory, he contended, “The most important single factor influencing learning is what the learner already knows”

2.27 Ausubel’s Theory of Meaningful Learning

Ausubel (1966) says that “Meaningful learning takes place if the learning task is related in a non-arbitrary and non-verbatim fashion to the learner’s existing cognitive structure”.

Johnson (1979) has explained that Ausubel’s theory consists of three principles of expository teaching: (1) the concepts are meaningful only when the student can visualize (i.e. elicits an image in the content of one’s consciousness) them and subsume them in the cognitive structure. (2) When teaching a concept, proceed from the most generic concepts to the most specific ones (i.e. the most general ideas of the subject should be presented first and then progressively differentiated in terms of detail and specifics). (3) Students’ readiness (which includes current knowledge, stage of cognitive development, and predominant mode of intellectual functioning) and integration of guest and host ideas through comparisons and cross-referencing of new and old ideas.

According to Ausubel’s assimilation theory (1968), knowledge is organized and structured in a hierarchical way, and there are three major components in this theory: (1) Hierarchical organization (2) Progressive differentiation and (3) Integrative reconciliation. He further goes on to say that people’s knowledge structures are from general concepts to more specific concepts, and prior knowledge is very important in learning about new concepts. Learning is enhanced when there are new relationships being set up between related concepts hierarchically. Deese’s association theory (1965), explains that knowledge is organized and structured around a general term or concept, so knowledge structures are like networks of associated concepts. Each concept is connected to the other concepts in the network. One activates a concept when trying to search and
learn the meaning of certain concept, and therefore activates the surrounding concepts (Shavelson, et.al.1993).

Learning is enhanced when there is strong and meaningful association in the network. Novak (1993), believe that the hierarchical knowledge structure makes necessary “an active integration of concepts”, and “Meaningful learning involves the assimilation of new concepts into existing cognitive structures”.

Ausubel (1978) believes that “the external world acquires meaning only as the learner converts it into the content of consciousness. Meaning is created through some form of representational equivalence between language (symbols) and mental context. Two processes are involved in his ‘Meaningful verbal learning (subsumption theory)’ (a) Reception, which is employed in meaningful verbal learning and (b) Discovery, which is involved in concept formation and problem solving.”

Ausubel saw two alternatives: reception or discovery. He only considered reception, regarding discovery as unhelpful. Bruner, of course, took the opposite view. Both are, of course, true.

2.28 Scope and Practical Application

Ausubel (1968), indicates that “his theory applies only to reception (expository) learning in school setting. He distinguishes reception learning from rote learning and discovery learning; the former because it does not involve subsumption (i.e. meaningful material) and the latter because the learner must discover information through problem solving.”

Shah (2004) quotes Ausubel as, “people think that they acquire knowledge primarily through reception rather than through discovery. He is in the favour that concepts, principles and ideas are presented and understood, not discovered. The more organized and focused the presentation, the more thoroughly the individual will learn.”
Ausubel believes that “learning should progress deductively – from the general to the specific, and not inductively, as Bruner recommended (from specific to general). He supports the use of direct instructional methods (lecture), and argues that large bodies of knowledge are best obtained through this type of learning.”

Direct instructional methods are much more than lecture. It can involve worksheets, textbooks, web cites as well as teaching with questioning. The key thing is that the instruction is directed by the teacher. This theory can help teachers as;
(1) We need to remember that inputs to learning are important.
(2) Learning materials should be well organized.
(3) New ideas and concepts must be potentially meaningful to the learner.
(4) Anchoring new concepts into the learner’s already existing cognitive structure will make the new concepts recallable.

Ausubel (1960), proposed his expository teaching model to encourage meaningful learning rather than rote reception learning. In his approach to learning, teacher presents material in the carefully organized sequenced and finished form. Students receive the most usable material in the most efficient way. It is most appropriate when we want to teach about the relationships among several concepts. Another consideration is the age of the students. This approach requires students to manipulate abstract ideas; this means expository teaching is more developmentally appropriate for students of elementary and secondary stages.

2.29 Reception learning

Ausubel, (1966), explained that the principle content of what is to be learned is presented to the learner in more or less final form. The information is provided directly to the learner and it does not involve discovery.

Ausubel (1966), considered that both discovery and the reception learning method could be classified either as meaningful or as rote learning. El-Banna, (1987), states that in reception learning, the content is presented to the students, either by teachers or by
written materials, in its final form. All that students have to do is to incorporate this content into their cognitive structure to learn it and remember it.

Ausubel proposed the idea of a subsumer as a point of attachment for new knowledge. According to Novak (1978), “any concept, principle or organizing idea that the learner already knows and that can provide association or anchorage for various components of new knowledge is a subsumer.” West and Fensham, (1974) in Zaman (1996), state that “the process of meaningful learning results in subsuming of new knowledge.”

Novak (1978), goes as far as to suggest that subsumption does not occur in the basic stage of development but rather results from growing differentiation and integration of relevant concepts in cognitive structure. Zaman (1996), says, “New knowledge is linked to especially relevant concepts or propositions and this process is continuous. Major changes in meaningful learning occur, not as a result of a stage of cognitive development, but rather as a result of growing differentiation and integration of specifically relevant concepts in cognitive structure.”

Zaman (1996), explained the ideas of other psychologists that if the subsumers or anchoring ideas or concept were there (in the pupils cognitive structure) the pupil was effectively ready. It seems that the Ausubel’s view of readiness/subsumer is close to that of Gagne. Shulmen (1970), supports this, he states, Ausubel was in fundamental agreement with Gagne in that the key to readiness was pre-requisite knowledge. MacGuire (1981), explained that during the process of subsumption both the anchoring concept and the new knowledge are modified but retain their separate identities. As a result of the continuity of modification and elaboration in the learner’s cognitive structure, meaningful learning occurs.

2.30 Ausubelian Teaching Method (Meaningful Learning Model)

Zaman (1996), states, “Preparation of the cognitive structure of the learner for a new learning task will facilitate the learning. This is the idea developing from the
Ausubel’s theory.” In Ausubel’s (1960) view, “to learn meaningfully, students must relate new knowledge (concepts, proposition, rule, principles) to what they already know.” He proposed a pedagogical strategy of using advance organizer, a way to help students link their ideas with new material or concepts. Advance organizers can be verbal phrases, a graphic, a model, or a question. In any case, the advance organizer is designed to provide, what cognitive psychologists called “mental scaffolding” to learn new information. West and Fensham (1974), describe this, “a verbal statement, presented to the learner before the detailed new knowledge”. Novak (1984) says, “the organizer is a small learning episode that is more general and more inclusive than the learning material that follows and that it is perceived by the learner to serve as a cognitive bridge between what he or she already knows and what is to be learned”.

Novak (1971), maintains that the advance organizer facilitates knew knowledge, when the material is novel and no relevant concept exists in the learner’s mind. Zaman (1996), says that “if the child is not ready in the sense of having appropriate subsumers, there is the possibility of using an advance organizers to bridge the gap”. Ausubel (1973) adds “the main goal of the advance organizers is to bridge the gap between what the learner already knows and what he or she needs to know.”

Ausubel (1960) emphasizes, “Advance organizers are different from overviews and summaries which simply emphasize key ideas and are presented at the same level of abstraction and generality as the rest of the material.” Novak (1978) says, “it is unlikely that any type of advance organizers will function, for the organizer itself must be meaningful to the learner”.

According to Vadidya (1996), “Organizers are of two types; Expository and Comparative. Expository organizers establish meaningful contact with the content and form of the cognitive structure. They provide optimal anchorage to the cognitive structure and thereby, reduce memorization. On the other hand comparative organizers establish discriminable focus, mutual comparisons of related concepts and provide learning in a
wider framework, and are more effective in the teaching-learning process because of their wider applicability.”

According to Ausubel (1960), “advance organizers serve three purposes: (1) They direct attention to what is important in the coming material; (2) They highlight relationships among ideas that will be presented; (3) They remind the students of relevant information already in memory”.

After presenting advance organizers in the first phase, the next phase is to presents the material in terms of basic similarities and differences by using examples and non-examples, and engages the students in meaningful learning activities.

In the third phase, teacher strengthens the cognitive structure by relating the new information to advance organizers and promote active reception learning.

A lecture has three parts: the introduction, the body, and the conclusion. It is during the introduction that Ausubel’s theory is most useful.

Ausubel (1963), believed that “learning proceeds from top-down, or deductive manner and not inductively as Bruner suggests.

Ausubel has achieved two great things: he separated clearly the meaningful-rote dimension from the reception-discovery dimension. He demonstrated the vital importance of prior knowledge in subsequent learning and this led to the feedback loop in the Johnstone Information Processing Model as well as much later research on the way information is stored in long term memory. Ausubel, perhaps, overemphasized reception and undervalued the role of discovery. Discovery has its placed but it needs to be guided.

2.31 Follow up studies of Ausubelian Theory

Several investigations are reported stemming from Ausubel’s theory. West and Fensham, (1974), have pointed out the obvious relation of Ausubel’s theory to the
teacher’s task making it eminently worthy of consideration and deserving wider acceptance than any other theory.

Ausubel’s theory is based on the part played by the learner’s prior knowledge and how the new knowledge interacts with it, to build his cognitive structure. Shavelson, (1972), reported that “the cognitive structure of learners undergoes changes during instruction in physics. Key facts and concepts were interrelated more closely at the end of the instruction than at the beginning. The learners’ cognitive structures correspond more closely”. Entwistle and Huggins, (1964), reported that, when two closely related concepts are taught together, the student learns less about either concept than they would if the concept were presented separately. The concepts seem to interfere with the meaningful learning process.

Kempa and Nicholls, (1983), supported Ausubel’s theory in the contribution of prior knowledge subsumers to the learning process. They tried to find a relationship between students’ problem solving ability and their cognitive structures. They found that good problem-solvers have a more complex cognitive structure than poor problem solvers. Ring and Novak, (1971), reported the same results after having investigated the effect of students’ existing cognitive structure on the learning of new material in the light of their achievement in college chemistry.

2.32 Traditional Teaching Methods (Rote Learning)

In the view of Qubain (1966), “the traditional teaching methods tend heavily toward classroom lectures, book learning by rote, and memorization of facts, equations, and formulas. Recitation usually consists of repeating without questioning what the book or instructor has stated.”

Qubain, (1966), neglects the strong emphasis in schools on the pupils believing everything the teacher says or the textbook states without considering it critically. This is a vital general skill but is also a key aspect of scientific thinking. I use to ask my own school students (from age 12-18) never to believe anything I said unless I gave them
supporting evidence. This generated a very healthy scientific view. It also made me re-think some of what I taught. For example, chemistry books teach that atoms ‘want to lose or gain electrons to have a full outer shell’. Think about it: it is nonsense. Look at it in terms of energy and the nonsense is even greater. For example, it is stated that a sodium atom wants to lose an electron. The ionization potential energy shows that energy must be added to the system to enable a sodium atom to lose an electron. We teach a lot of rubbish at times. I know this approach was of immense value to the students in later life-they told me. If this approach was used in all subject areas, many problems would be reduced.

Traditional teaching methods view teaching as a management procedure involving controlling the stimuli to which students are exposed and rewards they receive for learning. Johnson, (1979) expresses the views that what can be directly observed is important, and through using environmental stimuli and rewards to condition students, anything can be learned.

In the traditional teaching the teachers’ main focus is on memorization (rote learning). According to Vaidiya, (1996), rote learning is not meaningful in the process of internalization. It is arbitrary and verbatim in nature. It stays close to the cognitive structure of the learner but do not get integrated there. Hence as a result the learner exhibits a non-successful learning set.

Traditional teaching methods are fine for remembering sequences of objects (i.e. lists of structures) but do not aid the learner in understanding the relationships between the objects. Meaningful learning, therefore, is personal, idiosyncratic and involves recognition of the links between concepts. According to Novak and Gowin (1984), “Both rote and meaningful learning may be achieved no matter what instructional strategy is used either reception learning or discovery learning may result in meaningful learning. Therefore, it is not necessarily how information is presented but how the new information is integrated into the old knowledge structure that is crucial in order for meaningful learning to occur.
In rote learning the students just absorb the material in a parrot fashion, and may give the wrong impression of having understood what they have written or said. In Pakistan, it is strongly discouraged in the new curriculum of science and mathematics and first time the standards are set. Standards specifically emphasize the importance of deep understanding over the mere recall of facts, which is seen to be less important. The advocates of traditional education have criticized the new standards as slighting learning basic facts and elementary arithmetic, and replacing content with process-based skills.

Basic sciences must include the mastery of concepts instead of mere memorization and the following of procedures. It must include an understanding of how to make the learning material meaningful and to use the scientific equipments in the laboratory to arrive meaningfully at solutions to problems, to verify laws, principles.

The advocates of traditional methods argue that rote learning is the only way to learn material in a timely manner. For example, when learning the English alphabet, the vocabulary of a foreign (second or third) language, there is no inner structure or their inner complexity is too subtle to be learned explicitly in a short time.

Brevity is not always the case with rote learning. For example, many Muslims learn by heart and can recite the whole Holy Quran. Their ability to do so can be attributed, at least in some part, to having been assimilated by rote learning.

Rote learning is prevalent in many religious schools throughout the world. For example, Jewish use this approach when teaching children Torah and Muslim Madrasas utilize it in teaching of Holy Quran. It is used in various degrees, and more so, although far from exclusively, at a younger age, the main purpose being to memorize and retain as much textual material as possible, to prepare a student for a more analytical learning in the future.
CHAPTER 3
RESEARCH METHODOLOGY AND PROCEDURE

The study was undertaken to compare the differential effects of teaching of physics through Ausubelian and traditional teaching methods on students’ achievement and attitude, and to find out the effectiveness of pre-lab on the learning of the students in the physical science laboratory. The research work was carried out for the period of thirty-five weeks (August 2004-April, 2005) in the physical science classrooms and laboratory of Government Comprehensive High School for Boys, Jhelum.

In this chapter, the procedure and methodology of the study are described under the following headings:
- Population
- Sample
- Contents of the study
- Timetable
- Research Design
- Tools of the research study (construction, validation, improvement)
- Construction and validation of an instrument to measure the scientific attitude of the students
- Finalization of tools
- Data collection and data analysis procedure
- Concept mapping (specimen)
- Pre-lab (specimen)
- Post-lab (specimen)
- Ausubel’s Teaching Strategy (specimen)
- Traditional Teaching Strategy (specimen)
3.1 **Population Of The Study**

1. There were sixty boys’ secondary schools in District Jhelum in the year 2004. Out of sixty, only eight schools fulfilled the requirements (number of science students, physical facilities, well equipped science laboratory, science teacher, laboratory attendant/ assistant, etc.), set for this study. All the secondary school science male students of district Jhelum during the session 2004 – 2005 were taken as target population for this study.

2. For the construction and validation of the instrument to measure the scientific attitude of the students, all the secondary schools (boys & girls) of District Jhelum were the population of the study. In 2004 there were 100 secondary schools (60 boys & 40 girls) in District Jhelum.

3.2 **Sample of the Study**

1. Out of eight schools which fulfill the requirements set for this study, one school (Government Comprehensive School for boys, Jhelum city) was randomly selected as sample school.

   There were 140 science students in Government Comprehensive high school, Jhelum during the session 2004-2005. Sixty-two science students were randomly selected as a sample for this study. The sample was then divided in to two equivalent groups on the basis of an achievement test of 50 marks from the 8th class science, published by Punjab Text Book Board, Lahore. The test was constructed, tried-out, improved and administered to the whole sample of 62 subjects. The researcher evaluated the answer sheets and the marks were arranged in the descending order. The sample was then divided into two equal matched groups on the basis of marks achieved by the students on even/odd basis.

   The experimental group was then selected by randomization. The mean scores of the experimental and control groups on the test from the eight class science were calculated and presented in Table 4.1 in chapter 4.
2. To construct and validate an instrument to measure the scientific attitude of the students, a sample of 200 students (i.e. 10 students per school) were randomly selected from 10 male secondary schools (5 urban and 5 rural) and 10 female secondary schools (5 urban and 5 rural) of District Jhelum.

3.2 Contents of the Study

Theory: Physics text-book (Part I, Part II) published by the Punjab Text Book Board, Lahore for secondary classes were the syllabus for this study.

Practical work: Twenty experiments of physics were selected for the present study from the secondary school syllabus of the Board of Intermediate and Secondary Education (BISE) Rawalpindi. These twenty experiments cover more than ninety percent of the practical work and the theoretical concepts given in the prescribed physics book for secondary classes.

These experiments are:

1. Plot the graph between the volume and the column height of a liquid.
2. Measure the length and diameter of a solid cylinder with vernier callipers and calculate its volume.
3. Determine the thickness of a given wire by using a screw gauge and calculate its area of cross-section.
4. Find the acceleration of a body placed on an angle iron.
5. Find the mechanical advantage of an inclined plane.
6. Study the principle of moments.
7. Find the resultant of two vectors by graphic method.
8. Verify Hook’s law.
9. Find the center of gravity of an irregular shaped object.
10. Study the effect of length of a simple pendulum on the time-period, and find the value of ‘g’. Is it 9.8m/s?
11. Determine the speed of sound at room temperature by using a resonance tube.
12. Verify Ohm’s law/Study the relationship between current and voltage, also plot the graph between the two variables.
13. Plot the magnetic field (magnetic lines of forces) due to a bar magnet.
14. Find the density of solid body heavier then water.
15. To verify the characteristics of P-N junction.
16. To verify the truth table of AND & OR gates.
17. Study the laws of refraction of light by using glass slab.
18. Determine the focal length of a concave mirror by parallel method using one needle.
19. Determine the focal length of a convex lens by two-pin method.
20. Determine the critical angle of glass using a glass prism and calculate the refractive index of material of the prism.

3.4 Time Table

The research work was carried out for the period of thirty-five weeks in the secondary school physics classroom and laboratory of Government Comprehensive High School, Jhelum. The experimental group was given a treatment (Ausubel’s teaching strategy/meaningful learning) five days per week that is from Monday to Friday except Saturday in the physics classroom for the period of seventy minutes. At the same time the control group was taught by another science teacher (Muhammad Shabir) having qualification B.Sc., B.Ed., M.A., M.Ed. The teacher that taught to the control group and the researcher has the same academic and professional qualifications from the same institutions, and having the age 42 years.

In the physics laboratory of Government Comprehensive School Jhelum the students came once per week for one and half an hour. The control group came on each Saturday from 8:30 to 10:00, and the experimental group came from 10:00 to 11:30 in the physical science laboratory for practical work. A lecture of thirty minutes in the form of pre-lab was delivered to the experimental group and pre-lab sheet for each experiment was provided to them at least three days before the actual laboratory work. Each student with pre-lab was expected to do some preparatory work in the form of pre-lab before he
came to the laboratory. Pre-labs were developed by using Ausubel’s meaningful learning model by highlighting the essential work to be done.

To find the effectiveness of the pre-lab, some more work in the form of post-lab was administered to the whole sample (i.e. experimental & control) after the end of each practical. There was a great flexibility in the system that if any student was unable to attend one of his class/pre-lab/post-lab due to any reason, he was invited to attend on the next day. The researcher with the help of lab assistant conducted the lecture /pre-lab/post-lab. The post-labs consisted of some written work, objective type test-items, and some practical activities.

The timetable was prepared and adjusted with the regular timetable of the school.

3.5 Research Design

The posttest only equivalent group design was used for this study. It involved two groups; experimental and control, which were equated by random assignment on the basis of marks achieved by the students in the objective type test from class 8th science, published by Punjab Text Book Board, Lahore.

The experimental group received a treatment that is teaching through Ausubelian teaching method (meaningful learning), and at the end of experimental period, the mean test scores of the experimental and control groups were subjected to a test of statistical significance (t-test).

The design is the same as the pretest-posttest control group design except there is no pretest: subjects are randomly assigned to groups, exposed to the independent variable, and post-tested. Posttest scores are then compared to determine the effectiveness of the treatment. The combination of random assignment and the presence of control group serve to control for all sources of internal validity except mortality. But, if the probability of differential mortality is low, the post-test only group design is very effective. (Gay 1987, p-288)
Keeping in view the effectiveness of this research design, the researcher used it in this experiment. The symbolic representation of the research design is:

\[
\begin{align*}
 R & = \text{randomly selected} \\
 E & = \text{experimental} \\
 C & = \text{control} \\
 O & = \text{observation} \\
 T & = \text{treatment}
\end{align*}
\]

\[
\begin{align*}
 R & \quad E & = & \quad T & \quad O_1 \\
 R & \quad C & = & - & \quad O_2 \\
 \text{Difference} & = & O_1 & - & O_2
\end{align*}
\]

To make the design more understandable the researcher represented it in this form.

**Population:** Class X students of Jhelum Schools.

**Sample School:** Government Comprehensive boys School Jhelum.

**Sample:**

<table>
<thead>
<tr>
<th>Sample Type</th>
<th>Class</th>
<th>No. of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>X</td>
<td>31</td>
</tr>
<tr>
<td>Control</td>
<td>X</td>
<td>31</td>
</tr>
</tbody>
</table>
**Age Group of Sample:** 14½ to 16½ Years

**Independent Variables** (Treatment Variables):

1. Ausublian Teaching Method  
2. Traditional Teaching Method

**Dependent Variables:**

1. Achievement / Performance  
2. Scientific Attitude

**Level of Significance:** 0.05 / 0.01 / 0.001

### 3.5.1 Variables of the study and type of control employed

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Dependent Variable</th>
<th>Variable Control</th>
<th>Control Employed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching Methods</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i) Ausublian teaching method</td>
<td>i) Achievement/ Performance</td>
<td>1. Grade to be taught</td>
<td>1. Administrative (only class X was taught.)</td>
</tr>
<tr>
<td>ii) Traditional teaching method</td>
<td>ii) Scientific attitude</td>
<td>2. Academic subject to be taught in treatment</td>
<td>2. Administrative (only physics syllabus for secondary classes was taught.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Institutional variations (physical conditions)</td>
<td>3. Administrative (experiment was conducted in a single school)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Teacher</td>
<td>4. Both teachers were</td>
</tr>
</tbody>
</table>
variations of the same age (42yrs), same qualification from the same institutions, having same social background.

5. Gender variations
5. Only male students were taught as per treatment criteria.

6. Selection & size of the sample.
6. Administrative (two equivalent matched groups that is experimental and control. Each group contain 31 science students.)

7. Average age of the sample.
Both the groups had students of age between 14 ½ to 16 ½ years.

8. Situational variables.
i) Period of treatment
i) Both the groups were administered treatment between August 2004 to April 2005.

ii). Instructions during experiment
ii). Experimental group was taught by Ausuble’s teaching method and control group was taught by traditional teaching method.

iii). Duration of treatment
iii). Both the groups were taught 70 minutes per day during the
3.6 Variables

Different kinds of variables used in the study are as under:

3.6.1 Independent variables

Two types of variables have been taken note of in this study- (i) treatment variables and (ii) attribute or organismic variables.

3.6.1.1 Treatment variables

The teaching methods were used as treatment variables. The treatment variables consist of Ausubelian teaching method and Traditional teaching method. These variables were manipulated to study their comparative effectiveness. Two matched groups of class X science students were taught by structured lesson plans of physics based on these two teaching methods.

3.6.1.2 Attribute or organismic variables:

These attribute variables could not be altered by the experimenter though they had already been determined by the investigators. It was decided not to include these variables under study like, age, sex, race, and like variables. Best (1991), has agreed that such variables can be excluded from variables to be studied.
3.6.2 Dependent variables

The dependent variables or the criterions of the study were the achievement / performance and scientific attitude of the students.

3.6.3 Situational variables

Situational variables like time, duration of treatment, teacher, subject to be taught, use of teaching aids, institutional variations, condition of instruction, sample size, language of instruction, and the like were controlled administratively and through selection of the sample; equating of time, equating the groups through equal treatment and likewise. Some of these variables and their control are summed up in table 3.1 to follow.

3.7 Tools of the Research Study

A. Experimenter’s Tools

1. A test prepared from the 8th class science, and used to equate the two groups i.e. experimental & control.
2. Two Achievement Tests (i.e. Experimenter’s tool I and Experimenter’s tool II) were developed. Each test of 100 marks (theory 75 marks & practical 25 marks) was developed by the researcher, keeping in view the contents of the study and the Bloom’s Taxonomy of Educational objectives.
3. Pre-labs.
4. Post-labs.
5. Instrument to measure the scientific attitude of the students.

3.7.1 Finalization of the Tools (Construction, Validation, Improvement)

Test construction was made in four phases: (1) Planning Phase (2) Preparation Phase (3) Try-out Phase, and (4) Administration/evaluation Phase. (PPTA)
Planning Phase

The tests were planned keeping in view the concepts of validity, reliability and usability by answering the questions:

What objectives are to be measured? What and how much content area (theoretical and practical) is covered? How much weightage in the test is given to each objective of the Blooms Taxonomy? How many types of test-items/problems/questions are to be included? How long my test will be? To answer these questions blue print (a two way chart/table of specification) for each test was prepared and shown in the appendix-B. While planning the tools, all the cognitive aspects (levels) of the educational objectives (Bloom’s 1956) were taken into consideration.

Preparation Phase

At this stage, the objectives were written at the top of the two-way chart while the contents were written on the left column. Keeping in view the weightage given in the specification table, test-items/problems/questions (objective & subjective) were developed. The items/problems were taken from the content of the course and from everyday life. The language of the items/problems was kept very easy so that there should not be any difference in the understanding of the examiner, the teacher, the students and the researcher.

After the preparation of each test, it was discussed with the supervisor and experts in the field of science education, to know their opinion about the validity of the test, format, language and their distracters. On the basis of their opinion and suggestions, seven test items/problems were revised, as they were somewhat vague in nature. Problems / test items were taken from the physics textbook published by Punjab Textbook Board Lahore, and from everyday life. Table of specification for each tool is shown in Appendix-B.
**Try-out Phase**

After the discussion with the advisor, the tests were pilot tested on the number not included in the sample. After getting feedback, the tests were improved through the selection, substitution and revision of test items/problems and by using the item analysis procedure. The item analysis was made by taking 30 percent of the students who scored the highest and 30 percent of students who scored the lowest marks. This was done to select the items, which discriminate the best among the low and high achievers. The difficulty level of each item was also calculated by using statistical procedure. Out of fifty-seven items, forty items (that is twenty for each test) were selected for the final form of the tests. Scoring was done by the researcher himself very carefully.

**Administration phase**

After the improvement of each tool, these were administered to the whole sample according to the schedule given in the chapter one. The researcher evaluated the answer sheets, and the marks achieved by the students were kept in the record file of each student for further statistical procedures.

**3.7.2 Validity of the experimenter’s tools**

Although the tests were prepared on the basis of proper specification yet to ensure the content validity of the questions/test items, three professionals in the field of science education, assessed the bank of test questions for content validity. In the light of their suggestions, some items were revised and then these individuals confirmed that questions were relevant and correlated with the standards for science literacy.

**3.7.3 Reliability of the experimenter’s tools**

The reliability of the Experimenter’s Tools I & II was estimated by using split half method (by using formula KR-21), and was found to be 0.80 and 0.88.

**3.8 Attitude Questionnaire (Construction and Validation)**

As described in the procedure of the study, an attitude questionnaire was developed, aimed to measure the scientific attitude of the students at the end of the
academic session 2004-2005. The attitude scale (questionnaire) consisted of seven dimensions/subscales, such as curiosity, open mindedness, rationality, courage, objectivity, aversion to superstition and miscellaneous. Eight statements, four positive and four negative were constructed for each dimension (domain or subscale) of questionnaire.

Validity was checked by seeking opinions of a group of three experts in the field of science education. The statements were modified by means of discussion with the experts and on the basis of previous questionnaires.

At the last t-test was used to reject or accept the statements. For this purpose, the frequency distribution was considered of score based upon the responses to all students. 25% of the subject (50 in this case) with the highest total score and 25% of the subjects (i.e. 50) with the lowest total scores were taken with the assumption that these two groups provide the criterion groups in term of which to evaluate the statements.

\[
t = \frac{X_h - X_l}{\sqrt{\frac{S_h^2 + S_l^2}{n(n-1)}}}
\]

By using the above formula, the value of each statement was calculated and compared with the table value of ‘t’ at 0.05 level with degree of freedom (df) 98. The statement was accepted if the calculated value of ‘t’ for that particular statement was greater or equal than the table value otherwise it was rejected and excluded from the instrument. The calculation for one positive statement is given below:

By applying this procedure, the researcher found the values of ‘t’ for every statement. Then 28 statements were selected in such a away that two positive and two negative statements were chosen for each dimension having greater t-value.

The calculation of one positive statement is shown in the Appendix-C
The purpose of positive and negative statements was to check the consistency of the responses.

The dimensions to be measured by each item are shown in the following table.

Table 3.2  
*Attitude-Questionnaire Dimensions*

<table>
<thead>
<tr>
<th>DIMENSION</th>
<th>ITEM NUMBERS</th>
<th>FIVE POINT SCALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curiosity</td>
<td>1, 3 &amp; 2, 4</td>
<td>Strongly Agree to strongly disagree</td>
</tr>
<tr>
<td>Open mindedness</td>
<td>6, 8 &amp; 5, 7</td>
<td>Same as above</td>
</tr>
<tr>
<td>Rationality</td>
<td>9, 11 &amp; 10, 12</td>
<td>Same as above</td>
</tr>
<tr>
<td>Courage</td>
<td>13, 16 &amp; 14, 15</td>
<td>Same as above</td>
</tr>
<tr>
<td>Objectivity</td>
<td>17, 20 &amp; 18, 19</td>
<td>Same as above</td>
</tr>
<tr>
<td>Aversion to Superstition</td>
<td>21, 22 &amp; 23, 24</td>
<td>Same as above</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>25, 27 &amp; 26, 28</td>
<td>Same as above</td>
</tr>
</tbody>
</table>

3.8.1 Reliability of attitude questionnaire

Before analyzing the students’ attitude it is necessary to determine the reliability of the attitude-questionnaire. Many statistical methods are available for estimating reliability, the “internal consistency method” was chosen since this was the most convenient procedure to apply on this five points scale attitude-questionnaire. The chi-square test was used for the items employed.

The attitude questionnaire was composed of seven domains/ subscales. Each domain consists of four statements, two positive and two negative, aimed to check the consistency of the responses.
Total responses that is frequencies of the two positive statements of the first dimension/domain (curiosity) within the five point scale (from strongly agree to strongly disagree), was matched with the total responses of the two negative statements of the same dimension. This was employed until dimension number seven (item number twenty-eight). Then a chi-square test was applied for each two sets of responses, such as positive and negative statements of each dimension, to determine the significance of the difference between the frequencies of the two sets. The results are presented in table 3.2. The significant difference of the paired responses between two sets items (positive and negative) gave us a clear picture of the extent to which they measured, consistently.

From the table 3.2 it can be concluded that there is internal consistency except in the last dimension (miscellaneous). Since in this dimension the statements measure different aspects, therefore, inconsistency of responses in the set of items can be considered not to be serious.

After calculating the consistency of every dimension, the reliability of the instrument/attitude questionnaire was calculated by using formula KR-21, which was 0.9. The reliability coefficient showed that there is no significant difference in the consistency of responses between the positive and negative statements of the attitude questionnaire used in this study.
Table 3.3

The Consistency of Responses

<table>
<thead>
<tr>
<th>Statement No.</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>CHI-SQUARE Tabulated Value At 5% LOS=9.49, And 1% LOS=13.28, df=4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 &amp; 3</td>
<td>15</td>
<td>163</td>
<td>134</td>
<td>72</td>
<td>16</td>
<td>3.745&lt;T.V</td>
</tr>
<tr>
<td>2 &amp; 4</td>
<td>25</td>
<td>168</td>
<td>108</td>
<td>76</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>6 &amp; 8</td>
<td>20</td>
<td>160</td>
<td>120</td>
<td>86</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>5 &amp; 7</td>
<td>27</td>
<td>158</td>
<td>110</td>
<td>89</td>
<td>16</td>
<td>2.187&lt;T.V</td>
</tr>
<tr>
<td>9 &amp; 11</td>
<td>36</td>
<td>168</td>
<td>107</td>
<td>64</td>
<td>25</td>
<td>4.961&lt;T.V</td>
</tr>
<tr>
<td>10 &amp; 12</td>
<td>32</td>
<td>191</td>
<td>88</td>
<td>63</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>13 &amp; 16</td>
<td>19</td>
<td>116</td>
<td>175</td>
<td>70</td>
<td>11</td>
<td>7.031&lt;T.V</td>
</tr>
<tr>
<td>14 &amp; 15</td>
<td>14</td>
<td>103</td>
<td>210</td>
<td>55</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>17 &amp; 20</td>
<td>15</td>
<td>112</td>
<td>173</td>
<td>84</td>
<td>16</td>
<td>5.837&lt;T.V</td>
</tr>
<tr>
<td>18 &amp; 19</td>
<td>16</td>
<td>122</td>
<td>142</td>
<td>100</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>21 &amp; 22</td>
<td>16</td>
<td>101</td>
<td>222</td>
<td>56</td>
<td>15</td>
<td>4.152&lt;T.V</td>
</tr>
<tr>
<td>23 &amp; 24</td>
<td>15</td>
<td>88</td>
<td>215</td>
<td>66</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>25 &amp; 27</td>
<td>20</td>
<td>173</td>
<td>115</td>
<td>77</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>26 &amp; 28</td>
<td>22</td>
<td>107</td>
<td>176</td>
<td>84</td>
<td>11</td>
<td>14.733&gt;T.V</td>
</tr>
</tbody>
</table>
B. Term Tests

Two ready made tests of 100 marks (theory 75 marks & practical 25) were administered to the whole sample at the end of September and December 2004. The written tests and practical examinations were conducted under the supervision of the controller of examination of school. These tests were administered to the whole sample and evaluated by the science teachers of the school. The marks achieved by the sample were then obtained from the controller of examination, and saved for further statistical procedure.

C. Test for physics (theory and practical) prepared by Board of Intermediate and Secondary Education, Rawalpindi (SSC examination) spring 2005.

The data collected through the experimenter’s tools, and from the terms tests conducted by the examination branch of Government Comprehensive School, Jhelum was then verified by the marks achieved by the students in the Secondary School Certificate examination, spring 2005 conducted by the Board of Intermediate and Secondary Education, Rawalpindi.

The question papers in the subject of physics consisted of:
1. Physics theory of maximum marks 75.
2. Physics practical of maximum marks 25.

The whole procedure of annual examination SSC 2005 (i.e. from paper construction to declaration of result) was completed under the controller of examination (secrecy branch) of Board of Intermediate and Secondary Education, Rawalpindi.

After the declaration of the result of SSC examination, spring 2005, the result cards of the whole sample were taken from the in-charge school record for further statistical procedures.
3.9 Statistical Procedures

a. The t-test is a convenient way to find out the significant difference between the two mean scores at a selected probability level; that is, for a given sample size the ‘t’ indicates how often a difference (between the mean scores of experimental and control groups) is larger or larger would be found when there is no true population difference. In this study, the researcher used the t-test for independent samples to determine whether there is probably a significant difference (at level of significance, 0.05, 0.01 and 0.001) between the means of two samples (control group and experimental group). The data was analysed by the application of SPSS Version 15.

b. For attitude questionnaire, the Likert scale and t-test were used for the construction and validation of an instrument to measure the scientific attitude of the students. At the end of the experiment the attitude scale was delivered to both (the experimental and control) the groups, and marked. The marks achieved by both the groups were experienced by t-test to find the attitude gain through Ausubel’s teaching strategy.

c. Pearson correlation was used to determine the relationship between the scores achieved by the whole sample in the attitude scale and the marks achieved in the subject of physics in the annual examination 2005 conducted by the board of Intermediate and Secondary Education, Rawalpindi.

d. To find the reliability of the attitude scale, it was divided into two halves that is negative statements and positive statements, then the reliability coefficient between the tow halves was found. After that the reliability of the full instrument was calculated by using formula KR- 21, which was 0.90.

Chi-square test was applied for each two sets of responses (i.e. positive and negative) in each subscale, to determine the significance of the difference between the frequencies of the two items (i.e. the internal consistency of the subscales).
e. The reliability of the experimenter’s tools was calculated by applying Kuder Richardson formula (KR 21).

3.10 Concept Mapping

One of the tool that is used for instruction, and is work out on the basis of meaningful learning model is called ‘concept map’. According to Novak and Gowin (1984), “concept maps serve to clarify links between new and old knowledge and force the learner to externalize those links. These are very useful tools to help students learn about their knowledge structure and the process of knowledge construction (meta-knowledge), and also help the students learn how to learn (meta-learning)”.

In the view of Novak and Gowin, (1984) “the concept maps are visual images. They tend to be more easily remembered than text.” To represent meaningful relationships between concepts, the researcher identified the key concepts in the unit, ranked them, and prepared a network of concepts (concept map) of each unit (by arranging concepts logically) to make the content meaningful to students. The mega concept (general concept) was placed at the top, which includes less general concepts, which include most specific concepts to make the concepts progressively differentiated by their level of specificity.

The concept maps of all the chapters are shown in chapter 4.

3.11 Pre-Lab

In developing the set of twenty pre-laboratory exercises used here, the first step was to look at the experimental work in detail and to define the key underlying ideas which would be necessary to make sense of the work. The specific pre-laboratory tasks were then designed to ensure that these key ideas were understood. The set of pre-laboratory exercises were given to several experienced staff members for comments, and adaptations were incorporated.
Ausubel (1968) stated “if I had to reduce all of the educational psychology to just one principle, I would say this; the important single factor influencing learning is what the learner already knows.” Keeping in view the above-cited statement, the pre-labs for each experiment was prepared by highlighting the essential ideas related to the work to be done. The pre-lab was used to help students learn about their knowledge construction, that is the linkage between the guest (post-lab) and the host ideas/concepts.

**PRE-LAB: (Specimen)**

**“THE SIMPLE PENDULUM”**

Subject: Physics Class: X  
Date: 16-08-2004 Duration of period: 1 hr.

Note: All the students are informed that they must do the preparatory work before entering into the Lab.

**INSTRUCTIONAL MATERIAL**

a. Board, Duster, Chalk, etc.  
b. Iron Stand, Cork, Thread, Bobs of Different Masses, Vernier Callipers, Stop Watch.

Aims of pre-lab (General Aims)

1. To develop the scientific attitude among the students.  
2. To develop the power of observation and sense of enquiry amongst the students.  
3. To develop the reflective thinking in the students.

**SPECIFIC OBJECTIVES**

At the end of this session, the students will be able to perform the experiment “the simple pendulum” independently and measure the effects of different masses and lengths on its time-period.
PREVIOUS KNOWLEDGE OF THE STUDENTS

The researcher will identify in advance the ways to relate the new knowledge to some broad concepts already familiar to the students by the use of advance organizers.

The figure 3.1 shows the concept relationship with mega concept at the top.

*Figure 3.1 Concept map of “motion”*
What will I measure?

You will measure:
1. The diameter of the bob with the help of vernier callipers.
2. The total length of the simple pendulum.
3. The total time for thirty vibrations.
4. The time-period of the simple pendulum.
5. Average length of the pendulum.
6. Average time-period of the pendulum.

What should I know before I begin?

1. How to measure the diameter of the bob? (See the enclosed page)
2. How to calculate the total length of simple pendulum?
3. How to find the total time for thirty vibrations?
4. How to calculate time-period?
5. The relationship between length (1) and time-period (T).
   (See the enclosed page and consult your practical notebook)

Figure 3.2  Vernier Callipers

I. Vernier Callipers are used to measure accurately small length of the order of $10^{-1}$ mm. It consists of a sliding scale V called the vernier scale and a fixed graduated scale S called the main scale. Two jaws A and D are fixed at right angles to the main scale.
The other two jaws B and C, fixed perpendicular to the vernier scale, can slide with it along the main scale. The large pair of jaws measure, the depth and diameter of a cylinder / sphere. The smaller pair of jaws is used to measure the internal diameter of tube etc.

II. There are two scales on the vernier callipers.
1. Main scale  
2. Vernier scale

The smaller division on the main scale is in millimeter. The length of the vernier scale is 9 mm, which is divided into ten equal divisions of vernier scale (i.e. 0.9 mm = 1 division of vernier scale)

Smallest division of main scale = 1 mm
Smallest division of the vernier scale = 0.9 mm

*Least count (L.C.) or Vernier Constant (V.C.)*

Least count = smallest division of main scale – smallest division of vernier scale

\[ \text{Least count} = 1 \text{ mm} - 0.9 \text{ mm} = 0.1 \text{ mm} \text{ or } 0.01 \text{ cm} \]

Least count can also be calculated from the formula given below

\[ \text{L.C or V.C} = \frac{\text{smallest division on main scale}}{\text{total no. of divisions on the vernier scale}} \]

\[ = \frac{1 \text{ mm}}{10} = 0.1 \text{ mm} = 0.01 \text{ cm} \]

III. Now bring the jaws D and C in contact with each other. If the vernier zero exactly coincides with the main scale zero, there is no instrumental or zero error. (See fig. a) But if it is otherwise, there is error.

![Figure (a)](image-url)
Note the position of the vernier zero while the jaws are in contact. If the zero of the vernier scale lies on the right of the main scale zero, the error is positive but the correction would come out to be negative, which means that it is to be subtracted from all subsequent readings of the instrument.

At the position of contact, if vernier zero is to the left of main scale zero, the error is negative and the correction is positive. In order to find the positive error, look at the vernier scale from left to right and note the number of the particular division, which coincides with any main scale division. Multiply this number with vernier constant. The product would give the positive error. For example in Fig. (b) the 7th division of the vernier scale coincides with some main scale division. Therefore the positive error is:

\[ 7 \times 0.1 \text{ mm} = 0.7 \text{ mm} \text{ or } 7 \times 0.01 \text{ cm} = 0.07 \text{ cm}. \]

To determine the negative error, look at the vernier scale from left to right and note the number of the particular division, which coincides with any main scale division. Subtract this number from 10. Multiply the remainder with least count to obtain the negative error. For example in Fig (c), the 6th division of vernier scale coincides with some main scale division. Therefore the negative error is \((10 - 6) \times 0.1\text{ mm} = 0.4\text{ mm} \text{ or } 0.04\text{ cm}.\)
**How to measure the radius of the bob?**

Determine the zero error of the vernier callipers if any and then get the zero correction. Open the jaws and put given bob in them in such a way that the jaws touch the ends of the bob. Read the main scale reading to the left of the zero line of vernier scale, this gives the complete main scale division in centimeters.

Note the number of particular division, which joins with any of the main scale division. Multiply this number with vernier constant this gives the complete vernier scale division in centimeter. Add the main scale reading in vernier scale, this gives the observed diameter of the bob. Take three observations at three different points and apply zero correction to get correct value of diameter. Calculate the mean diameter and then calculate the radius ‘r’ by dividing the diameter by 2 \( (r = d/2) \)

**Find the zero error in this figure?**

![Figure (d)](figure(d)

**What is the reading in this figure?**

![Figure (e)](figure(e)
**Procedure:**

Take a fine thread about 100 to 150 cm long and rub it with cobbler’s wax to avoid rotatory motion of the bob due to the twists of the thread. Tie one end of the thread to the hook of the bob and other end between the spaces of the spilt cork and tie it firmly to an iron stand. Place the iron stand on the table in such a way that the bob is just a few centimeters (2 – 4) above the floor. Mark two points A and B at a distance of nearly 5cm as shown in the figure f. Take the bob to one of the points A or B and release it very gently. It will start vibrating.

![Simple Pendulum](image)

**Figure 3.3**

Take a Stop Watch. Study its scales. Hold it in your hand.

**How to count vibrations?**

Watch the motion of the bob. When it just passes from the mark O, start the Stop Watch. When the bob crosses point O again in the same direction, one vibration has been completed. In the same manner, count 30 vibrations. Stop the watch just when the 30th vibration has been completed. Note the time taken by the bob to complete 30 vibrations. Repeat it again without changing its length. Find the mean time for 30 vibrations. Calculate time-period $T$ that is the time for one vibration.

Measure the length of the pendulum ($l = l_1 + r$).

After noting $T$ and $l$ in the table, study the relation between them.

Repeat experiment with different length and find $l/T^2$ in each case.
Check that $l \propto T^2$ or $l / T^2 = \text{Constant}$

### 3.12 Post-Lab

A small but comprehensive post-lab was introduced at the end of each experiment. The first purpose of introducing this post-lab was to relate the theory with the practical work (i.e. to verify laws, principles.) and to interlink the pre-lab knowledge with the post-lab knowledge. And the second purpose was to find the effects of pre-lab on the learning of the students. Post-lab problems were chosen from the physics Text Book for secondary classes and from every day life. According to Johnstone (1998), “the major purpose is to develop students’ interest in physics, to engage them more and relate the subject to their own experiences. This can help them to develop a better understanding of the subject (experiment).” The post-lab was given to the whole sample at the end of each experiment.

Post-lab developed for the experiment, “the simple pendulum” is presented below as a specimen.

**POST-LAB (specimen)**

Name: _____________________  Roll No. ____________________
School: ___________________  Marks Obtained: ____________

**POST-LAB “THE SIMPLE PENDULUM”**

The following questions will help you to consolidate the work you did in the lab and help us to improve the teaching – learning process in the lab.

**(Part A)**

(6x1 = 6)

Read the statements carefully and tick (✓) the correct answer.

1. The time-period of second pendulum is:
   (a) 0.02 sec.  (b) 0.2 sec.
   (c) 2.0 sec.  (d) 2.2 sec.
2. A simple pendulum is made of plastic ball (as a bob) filled with water and have a hole in it. During the oscillation, due to the flow of water, its mass decreases. What will be the effect on the time-period of the pendulum? (Law of mass of simple pendulum)
   (a) It will increase   (b) It will decrease
   (c) It will remain same   (d) none of the, a, b, c.

3. If the bob of the pendulum of given length is replaced by another bob of different material what will be the effect on the time-period of the pendulum?
   (a) It will increase   (b) It will decrease
   (c) It will remain same   (d) none of the, a, b, c.

4. If the oscillation of a simple pendulum of a given length became small. What will be the effect of smaller oscillations on the time-period of the pendulum? (Law of isochronisms)
   (a) It will increase   (b) It will decrease
   (c) It will remain the same   (d) none of the, a, b, c.

5. If we decrease the length of the simple pendulum. What will be the effect of length on the time-period of the pendulum? (Law of length)
   (a) It will increase   (b) It will decrease
   (c) It will remain the same   (d) none of the, a, b, c.

6. Second pendulum is one whose time-period is two seconds. What is its frequency?
   (a) 0.5 Hertz   (b) 1.0 Hertz
   (c) 1.5 Hertz   (d) 2.0 Hertz

(Part B)  
(2×1 = 2)

Write the short answers (on the space given below) of the following questions.

1. Will a pendulum of a clock that keeps correct time at Karachi, be accurate at the mountain K2.

_______________________________________________________________________

2. Give two examples of motion’s that are simple harmonic.

_______________________________________________________________________

_______________________________________________________________________
By using formula \( T = 2\pi \sqrt{l/g} \). Find the value of \( g \) by taking the mean length \((l)\) and the time-period \((T)\) from your experiment you have just done. Is it 9.8 m/s\(^2\) (approximately)?

### 3.13 Traditional Teaching Method (Rote Learning)

The traditional teaching method tends heavily toward classroom lectures, book learning by rote, and memorization of facts, equations, and formulas. The teachers neither ask the students for any further readings related to the material learned in the class nor ask to differentiate or integrate the previous learned material.

#### Model Lesson Plan (Traditional Teaching Method)

**Subject:** Physics  
**Topic:** Force and Acceleration  
**Objective:** After study this lesson the students will be able to:
- Define Newton 3\(^{rd}\) law of motion  
- Give example of Newton’s 3\(^{rd}\) law of motion  
**Teacher:** How many of you can define Newton’s 1\(^{st}\) and 2\(^{nd}\) laws of motion.  
**Teacher:** Mr. Waqas please define 1\(^{st}\) law.  
**Waqas:** “Every object continues its state of rest, or of uniform motion in a straight line, unless it is acted upon by an external force.”  
**Teacher:** Thank you Mr. Waqas.  
**Teacher:** Now define Newton’s 2\(^{nd}\) Law of Motion Mr. Usman.  
**Usman:** “When a force acts on an object it produces an acceleration in its own direction which is directly proportional to the magnitude of the force and inversely proportional to the mass of the object.”  
**Teacher:** What is the relationship between ‘\(a\)’ and ‘\(F\)’ (Mathematically)?  
**Teacher:** Mr. Muneeb Write it on the blackboard.  
**Mr. Muneeb:** \(a \propto F\) (for a constant mass)  
**Teacher:** Good Muneeb. OK, student, today we will study Newton 3\(^{rd}\) law of motion.
Mr. Usman read aloud Newton’s 3rd law of Motion.

**Usman:** “For every action there is an equal and opposite reaction.

**Teacher:** Learn it by heart within five minute. And think of the example of this law. Now look at the example on the page 81. You can see a book on the table. The weight of book is acting in the downward direction. It is a reaction while the table applies the same force in the upward direction. This is reaction Hence action and reaction are equal but opposite in direction. Similarly, the motion of the rocket and firing a bullet from a gun are the examples of the Newton’s third law of motion.

**Teacher:** Write the answer of the Question No. 3 in your notebook (state Newton’s third law of motion, give three examples from everyday life).

### 3.14 Ausubelian Teaching Method

In the view of Johnson (1979), the information processing view divides learning into three phases (i) attending to new information (ii) acquiring and retaining information, and (iii) retrieving information from memory and transferring it to new situation.

In this way, the learner selects and interprets new information in terms of what he/she already knows.

**Presentation of the material in the class room/lab**

The major idea of Ausubelian teaching method is that the most important factor influencing learning is the quantity, clarity and logical organization of a learner’s present knowledge. This present knowledge is referred to as his cognitive structure.

The major instructional mechanism proposed by Ausubel is the use of advance organizers: “These organizers are introduced in advance of learning itself.” Organizers may be of different kind but the researcher used this concept in the form of a question /a diagram/a model/ structure of a discipline. Ausubel (1968) stated, “In any case the
advance organizers are designed to provide the “mental scaffolding” to learn new knowledge (information). Ausubel’s theory consists of three phases (i) presentation of an advance organizer (ii) presentation of learning task or material and (iii) strengthening the cognitive organization through integration and differentiation (by the use of examples and non-examples).”

In the light of Ausubel’s teaching strategy the whole content (theory and practical) was developed and presented in the physics classroom and laboratory for the period of 35 weeks.

Table 3.4  

Phases of Ausubel’s Teaching Strategy

<table>
<thead>
<tr>
<th>Phase One: Advance Organizer</th>
<th>Phase Two: Presentation of Learning Task or Material</th>
<th>Phase three: Strengthening Cognitive Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clarify aim of the lesson</td>
<td>Make the Organization of the new material explicit.</td>
<td>Relate new information to advance organizer</td>
</tr>
<tr>
<td>Concept mapping</td>
<td>Make logical order of learning material explicit.</td>
<td>Promote active reception learning.</td>
</tr>
<tr>
<td>Present the organizer</td>
<td>Present material and engage students in meaningful learning activities.</td>
<td></td>
</tr>
<tr>
<td>Relate organizer to students’ knowledge</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.15 Model Lesson Plan (Ausubelian Teaching Method)

**Topic:** Pressure and atmospheric pressure  
**Class X**

**Time:** 1 hour 10 min.

**Concepts:** matter and its properties, stress, force, area, Newton’s third law of motion.

**General objectives:** To develop the sense of reasoning and logical thinking and scientific attitude among the students.

**Specific Objective:** After the end of this session, the students will be able to:

- Define matter and name some of its properties.
- Define the concepts of force, area, and pressure.
- Find the relationship between force and pressure.
- Find the relationship between area and pressure.
- Find the relationship between temperature and pressure.
- Apply the concept of pressure in daily life.

Dear students I hope you all will be fine.

O.K. like previous lessons we will study this lesson too in the same manner. In the beginning I will ask you some questions about the concepts, of which you are already familiar just to refresh your previous knowledge and to develop the linkage between the learnt material and the material to be learnt.

- **Teacher:** (just food for thought)
- Students do you ever think why athletes / player use spikes?
- Why is it easy to cut with a sharp knife than a blunt one although the applied force is same?
### Table 3.5 Lesson Plan (Phases of Ausubelian Teaching Method)

<table>
<thead>
<tr>
<th>Phase One Advance Organizer</th>
<th>Phase Two Presentation of Learning Task or Material</th>
<th>Phase Three Strengthening Cognitive Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Define matter.</td>
<td>• Pressure</td>
<td>• Keeping in view of concept of pressure justifying how horse is faster than camel.</td>
</tr>
<tr>
<td>• Name and recall some properties of matter; weight, volume, force, area etc.</td>
<td>• P = F/A</td>
<td>• Why athletes use spikes?</td>
</tr>
<tr>
<td>• Air and all other material things exert pressure, and have weight.</td>
<td>• Pressure depends upon Force and Area</td>
<td>• How you differentiate between stress and pressure?</td>
</tr>
<tr>
<td>• What is force?</td>
<td>• Unit of Pressure ((N/m^2) or Pascal)</td>
<td>Are these scalars or vector quantities?</td>
</tr>
<tr>
<td>• Weight is a force.</td>
<td>Examples (Blunt nail vs. sharp nail, Flat Shoes / Sandal with heel.</td>
<td></td>
</tr>
<tr>
<td>• Unit of force.</td>
<td>• Difference between stress and pressure.</td>
<td></td>
</tr>
<tr>
<td>• Area and its units.</td>
<td>• Which Triangle has greater pressure A or B?</td>
<td></td>
</tr>
<tr>
<td>• Volume</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
\begin{align*}
\text{A} & \quad \text{B} \\
\end{align*}
\]
In the first phase the teacher clarifies the concepts of force, area, weight, volume and the like with the help of a question, a diagram, or an activity, before the start of actual topic.

- Force is an agent, which changes or tends to change, stop or tends to stop the moving objects.
- Weight is a force with which the Earth attracts the bodies towards its center.
- Volume is the space occupied by an object. (3 dimension: length*width*height)
- Area is the extent or measurement of surface (2 dimension)
- The unit of force and weight is N, area is sq. m. and volume is cubic meter.

\[ \pi r^2 \quad \text{length} \times \text{width} \quad \text{side} \times \text{side} \]

**SECOND PHASE**

**Pressure**

Pressure is defined as force per unit area.

Mathematically \[ P = \frac{F}{A} \]

The standard unit for pressure is Pascal (Pa), which is a Newton per square meter \( (N/m^2) \).

This special name for the unit was added in 1971; before that, pressure in SI was expressed simply as \( N/m^2 \).

It is a scaler quantity. Let us look at a static gas; one that does not appear to move or flow. The gas as a whole does not appear to move, the individual molecules of the gas, which we cannot see, are in constant random motion. Because we are dealing with a nearly infinite number of molecules and because the motion of the individual molecules is random in every direction, we do not detect any motion. If we enclose the gas within a container, we detect a pressure in the gas from the molecules colliding with the walls of our container. We can put the walls of our container anywhere inside the gas, and the force per unit area (the pressure) is the same. We can shrink the size of our "container"
down to an infinitely small point, and the pressure has a single value at that point. Therefore, pressure is a scalar quantity, not a vector quantity. It has a magnitude but no direction associated with it. Pressure acts in all directions at a point inside a gas. At the surface of a gas, the pressure force acts perpendicular to the surface.

For an object sitting on a surface, the force pressing on the surface is the weight of the object, but in different orientations it might have a different area in contact with the surface and therefore exert a different pressure.

\[ \text{Pressure} = \frac{\text{Force}}{\text{Area}} = \frac{F}{A} \]

Figure 3.4 Different Area in Contact Exert Different Pressure

It is clear from the above equation that pressure depends upon force and area.

**Teacher:** Who will tell, what is the relationship between pressure and force, Pressure and area?

Many student raise hands

**Ali:** Pressure and Force are directly related to each other while Pressure and area have indirect relation.

**Teacher:** Thank you Ali. Now look at the figure on the blackboard and tell me which block has greater Pressure? The block in flat position or the block in erected position?

**Haroon:** Both have same pressure.

**Teacher:** Class do you agree with Haroon?

**Awis:** Sir, The block in erected position has greater pressure due to lesser area.

**Teacher:** Thank you very much.
There are many physical situations where pressure is the most important variable. If you are peeling an apple, making your shave, then pressure is the key variable: if the knife and the razor is sharp, then the area of contact is small and you can peel or shave with less force exerted on the blade.

If you must get an injection, then pressure is the most important variable in getting the needle through your skin: it is better to have a sharp needle than a dull one since the smaller area of contact implies that less force is required to push the needle through the skin.

Teacher: (This is your home assignment) Explain why athletes use spikes?
CHAPTER 4

ANALYSIS OF DATA AND INTERPRETATION

This study was conducted to compare the effectiveness of the two teaching strategies i.e. Ausubel’s Teaching Strategy and Traditional Teaching Strategy. An experimental research design (posttest only control group design) was used to see the effectiveness of both the teaching methods. Secondary school science students (10th class) were the population of this study. Sampled students were randomly assigned to treatment and control groups. Treatment group was taught through Ausubel teaching strategy while control group was taught through traditional teaching strategy. This experiment was conducted for a period of 35 weeks. At the end of the study (experiment) four measurements were observed through, (i) Experimenters Tools (ii) School Test (iii) Secondary School Certificate Examination 2005 “Physics” (iv) Attitude Scale. To find the significant deference between the mean scores, t-test was applied. Different hypotheses were developed regarding different objectives of the study.

Table 4.1

Data regarding achievement score of 8th class science to equate the groups.

<table>
<thead>
<tr>
<th>Group Formation (Whole Sample)</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>31</td>
<td>30.1</td>
<td>7.31</td>
<td>-.111</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Control</td>
<td>31</td>
<td>29.8</td>
<td>7.03</td>
<td>df = 60</td>
<td></td>
</tr>
</tbody>
</table>

A test from 8th class science was constructed, tried out, improved and administered to the whole sample of 62 science students. One student from the control
group has not been able to complete the experimental period i.e. 35 weeks and struck off from the school and experiment and declare dead.

The t-test was applied to evaluate whether there was any significant difference between the mean scores of students in the 8th class science test. The result indicated that there is no significant difference between the mean scores of the experimental group (M = 30.1, SD = 7.31) and control group (M = 29.8, SD = 7.03), t (59) = -.111. It is concluded that both the groups were same in achievement before the treatment.
Figure 4.1  Data regarding achievement score of 8th class science to equate the groups. (Whole Sample)
First Objective

To compare the effects of Ausubelian teaching method (meaningful learning) and traditional teaching method (rote learning) on the achievement of the students in the subject of physics.

The corresponding null hypotheses are formulated as follows.

\( H_{01} \). There is no significant difference between the achievement scores of students in the subject of Physics (Theory) taught through Ausubelian and Traditional teaching method as measured by experimenter’s tools ‘1’.

Table 4.2

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausubelian Teaching Method (ATM)</td>
<td>31</td>
<td>30.1</td>
<td>14.9</td>
<td>2.42</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Traditional Teaching Method (TTM)</td>
<td>30</td>
<td>21.9</td>
<td>11.3</td>
<td>df = 59</td>
<td></td>
</tr>
</tbody>
</table>

The t-test was applied to evaluate whether there was any significant difference between the achievement scores of students in the subject of Physics (theory) taught through Ausubelian and Traditional teaching methods as measured by experimenter’s tool ‘1’. The result indicated that the mean concern for Ausubelian teaching method \( (M = 30.1, \ SD = 14.9) \) was significantly greater than the mean concern for Traditional teaching method \( (M = 21.9, \ SD = 11.3) \), \( t \ (59) = 2.42 \). As our calculated t-value (2.42) is greater than the t-tabulated value (2.01), therefore, the above stated hypothesis is rejected.
Hence, it is concluded that Ausubel’s teaching method helps to improve the conceptual understanding of secondary school students in the subject of physics. The findings of this study support the findings of Ausubel (1960), Ausubel (1978), Siddiqui (1993).

The clear picture that emerged from the table 4.1 is shown below in the form of bar diagram.
Figure 4.2  Data for the achievement scores of students in the subject of Physics (Theory) collected through Experimenter’s research tool ‘1’.
H_{02}. There is no significant difference between the achievement scores of the students in the subject of Physics (Practical) taught through Ausubel’s and Traditional teaching strategies as measured by experimenter’s tool ‘1’.

Table 4.3

Data for the achievement scores of students in the subject of Physics (Practical) collected through Experimenter’s research tool ‘1’.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausubelian Teaching Method (ATM)</td>
<td>31</td>
<td>16.6</td>
<td>3.6</td>
<td>4.008</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Traditional Teaching Method (TTM)</td>
<td>30</td>
<td>13.4</td>
<td>2.8</td>
<td>df = 59</td>
<td>.008</td>
</tr>
</tbody>
</table>

The t-test was applied to evaluate whether there was any significant difference between the achievement scores of students in the subject of Physics (Practical) taught through Ausubel and Traditional teaching strategies as measured by experimenter’s tool ‘1’. The result indicated that the mean concern for Ausubel’s teaching strategy ($M = 16.6$, $SD = 3.6$) was significantly greater than the mean concern for Traditional teaching strategy ($M = 13.4$, $SD = 2.8$), $t(59) = 4.008$. As our $t$-calculated value is greater than the $t$-tabulated value, therefore the above stated null hypothesis “There is no significant difference between the achievement scores of the students in the subject of Physics (Practical) taught through Ausubel’s and Traditional teaching strategies as measured by experimenter’s tool ‘1’” was rejected.

The findings of this study are consistent with the findings of the research studies conducted by Siddiqui (1993), Zaman (1996), and specifically consistent with the finding of Shah (2004). Hence this study helps to improve the students’ understanding of concepts in the physical science laboratories.
It is indicated that students taught through Ausubel’s teaching strategy performed better than the students taught through traditional teaching strategy. Hence the null hypothesis rejected.

Figure 4.3  Data for the achievement scores of students in the subject of Physics (Practical) collected through Experimenter’s research tool ‘1’.
There is no significant difference between the achievement scores of the students in the subject of Physics (Theory + Practical) taught through Ausubel and Traditional teaching strategies as measured by experimenter’s tool ‘I’.

Table 4.4

*Data for the achievement scores of students in the subject of Physics (Theory+Practical) collected through Experimenter’s research tool ‘I’.***

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausubelian Teaching Method</td>
<td>31</td>
<td>46.8</td>
<td>17.5</td>
<td>2.91</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>Traditional teaching Method</td>
<td>30</td>
<td>35.2</td>
<td>13.1</td>
<td>df = 59</td>
<td></td>
</tr>
</tbody>
</table>

The t-test was applied to evaluate whether there was any significant difference between the overall (Theory + Practical) achievement scores of students in the subject of Physics taught through Ausubel and Traditional teaching strategies as measured by experimenter’s tool ‘I’. The result indicated that the mean concern for Ausubel’s teaching strategy (M = 46.8, SD = 17.5) was significantly greater than the mean concern for Traditional teaching strategy (M = 35.2, SD = 13.1), t (59) = 2.91.

As the mean score of the experimental Group (46.8) is greater than the mean score of control group (35.2), it indicates that the difference in the achievement and attitude is significant, and is due to the treatment and is not by chance. Therefore, the hypothesis stated above is rejected.

The findings of this study were consistent with the finding of Pandey (1986), Stenbrink (1970). On the other hand Ausubel’s teaching Strategies (ATS) and Traditional teaching Strategies (TTS) were found equally effective by Feller (1973), Goodman (1977).

A clearer picture that emerged from Table 4.3 is presented in the form of bar diagram.
Figure 4.4  Data for the achievement scores of students in the subject of Physics (Theory + Practical) collected through Experimenter’s research tool ‘1’.
There is no significant difference between the achievement scores of students in the subject of Physics (Theory) taught through Ausubel’s and Traditional teaching strategies as measured by experimenter’s tools ‘2’.

Table 4.5

Data for the achievement scores of students in the subject of Physics (Theory) collected through Experimenter’s research tool ‘2’.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausubelian Teaching Method (ATM)</td>
<td>31</td>
<td>34.7</td>
<td>12.9</td>
<td>3.92</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Traditional teaching Method (TTM)</td>
<td>30</td>
<td>23.5</td>
<td>9.3</td>
<td>df = 59</td>
<td></td>
</tr>
</tbody>
</table>

The t-test was conducted to evaluate whether there was any significant difference between the achievement scores of students in the subject of Physics (Theory) taught through Ausubel and Traditional teaching strategies as measured by experimenter’s tool ‘2’. The result indicated that the mean concern for Ausubel’s teaching strategy (M = 34.7, SD = 12.9) was significantly greater than the mean concern for Traditional teaching strategy (M = 23.5, SD = 9.3), t (59) = 3.92.

The mean score of the experimental Group (34.7) is greater than the mean score of control group (23.5). Therefore, the hypothesis stated above is rejected. Ausubel’s teaching strategies had a significant effect on achievement and retention situation positively to traditional methods. These effects were found in the researches of Johnson (1981), Gupta (2004), and the more.

It is indicated that students taught through Ausubel’s teaching strategy performed better than the students taught through traditional teaching strategy.
To have further in sight into the mean scores of students’ achievement presented in the table 4.4, the comparison is represented as bar diagram and is shown below.

*Figure 4.5* Data for the achievement scores of students in the subject of Physics (Theory) collected through Experimenter’s research tool ‘2’.
\[ H_{05} \] There is no significant difference between the achievement scores of the students in the subject of Physics (Practical) taught through Ausubel’s and Traditional teaching strategies as measured by experimenter’s tool ‘2’.

Table 4.6

_Data for the achievement scores of students in the subject of Physics (Practical) collected through Experimenter’s research tool ‘2’._

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausubelian Teaching Method (ATM)</td>
<td>31</td>
<td>14.3</td>
<td>4.1</td>
<td>4.45</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Traditional Teaching Method (TTM)</td>
<td>30</td>
<td>10.5</td>
<td>2.4</td>
<td>df = 59</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>

The t-test was conducted to evaluate whether there was any significant difference between the achievement scores of students in the subject of Physics (Practical) taught through Ausubel and Traditional teaching strategies as measured by experimenter’s tool. The result indicated that the mean concern for Ausube’s teaching strategy \((M = 14.3, SD = 4.1)\) was significantly greater than the mean concern for Traditional teaching strategy \((M = 10.5, SD = 2.4)\), \(t(59) = 4.45\).

The mean score of the experimental Group (14.3) is greater than the mean score of control group (10.5), it indicates that the difference in the achievement is significant, and is due to the treatment and is not by chance. Therefore, the hypothesis stated above is rejected.

The results support the finding of Shah (2004), Shian and Janice (2004).

It is indicated that students taught through Ausubel’s teaching strategy performed better than the students taught through traditional teaching strategy.
Figure 4.6 Data for the achievement scores of students in the subject of Physics (Practical) collected through Experimenter’s research tool ‘2’.
There is no significant difference between the achievement scores of the students in the subject of Physics (Theory + Practical) taught through Ausubel and Traditional teaching strategies as measured by experimenter’s tool ‘2’.

Table 4.7

*Data for the achievement scores of students in the subject of Physics (Theory + Practical) collected through Experimenter’s research tool ‘2’.*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausubelian Teaching Method (ATM)</td>
<td>31</td>
<td>49.1</td>
<td>15.4</td>
<td>4.51</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Traditional Teaching Method (TTM)</td>
<td>30</td>
<td>33.9</td>
<td>10.2</td>
<td>df = 59</td>
<td></td>
</tr>
</tbody>
</table>

The t-test was conducted to evaluate whether there was any significant difference between the overall (Theory + Practical) achievement scores of students in the subject of Physics taught through Ausubel and Traditional teaching strategies as measured by experimenter’s tool ‘2’. The result indicated that the mean concern for Ausubel’s teaching strategy (M = 49.1, SD = 15.4) was significantly greater than the mean concern for Traditional teaching strategy (M = 33.9, SD = 10.2), t (59) = 4.51. It is indicated that students taught through Ausubel’s teaching strategy performed better than the students taught through traditional teaching strategy.

Ausubel’s teaching strategy had significant effect on active learning, achievement, and retention situation positively to traditional method and these effects were found in the research studies of Ausubel (1960), Ausubel and Fitzgerald (1963), Smith (1976), Johnson (1981), Novak (2001), Gupta (2004). On the other hand, some of the research studies indicated equal effect of ATS and TTS. These research studies are of Tennyson (1985), Johnson (1980), Moore (1981), Noel (1983), etc.
Figure 4.7 Data for the achievement scores of students in the subject of Physics (Theory + Practical) collected through Experimenter’s research tool ‘2’.
There is no significant difference between the total achievement scores of the students in the subject of Physics (Theory) taught through Ausubel and Traditional teaching strategies as measured by experimenter’s tool ‘1 and 2’.

Table 4.8

Data for the achievement scores of students in the subject of Physics (Theory) collected through Experimenter’s research tools ‘1 & 2’.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausubelian Teaching Method (ATM)</td>
<td>31</td>
<td>64.9</td>
<td>24.4</td>
<td>3.52</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Traditional Teaching Method (TTM)</td>
<td>30</td>
<td>45.3</td>
<td>18.4</td>
<td>df = 59</td>
<td></td>
</tr>
</tbody>
</table>

The t-test was conducted to evaluate whether there was any significant difference between the overall achievement scores of students in the subject of Physics (Theory) taught through Ausubel and Traditional teaching strategies as measured by experimenter’s tool ‘1 and 2’. The result indicated that the mean concern for Ausubel’s teaching strategy (M = 64.9, SD = 24.4) was significantly greater than the mean concern for Traditional teaching strategy (M = 45.3, SD = 18.4), t (59) = 3.52.

The mean score of the experimental Group (64.9) is greater than the mean score of control group (45.3), it indicates that the difference in the achievement is significant, and is due to the treatment and is not by chance. Therefore, the hypothesis stated above is rejected.

The results support the finding of Ausubel (1960), Pandey (1986), and Kinchin (2000).
Figure 4.8 Data for the achievement scores of students in the subject of Physics (Theory) collected through Experimenter’s research tools ‘1 & 2’.
H_{08}. There is no significant difference between the total achievement scores of the students in the subject of Physics (Practical) taught through Ausubel and Traditional teaching strategies as measured by experimenter’s tool ‘1 and 2’.

Table 4.9

*Data for the achievement scores of students in the subject of Physics (Practical) collected through Experimenter’s research tools ‘1 & 2’.*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausubelian Teaching Method (ATM)</td>
<td>31</td>
<td>31.0</td>
<td>6.9</td>
<td>5.10</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Traditional Teaching Method (TTM)</td>
<td>30</td>
<td>23.8</td>
<td>3.4</td>
<td>df = 59</td>
<td></td>
</tr>
</tbody>
</table>

The t-test was conducted to evaluate whether there was any significant difference between the overall achievement scores of students in the subject of Physics (Practical) taught through Ausubel and Traditional teaching strategies as measured by experimenter’s tool ‘1 and 2’. The result indicated that the mean concern for Ausubel’s teaching strategy (M = 31.0, SD = 6.9) was significantly greater than the mean concern for Traditional teaching strategy (M = 23.8 SD = 3.4), t (59) = 5.10.

The mean score of the experimental Group (31.0) is greater than the mean score of control group (23.8), it indicates that the difference in the achievement and attitude is significant, and is due to the treatment and is not by chance. Therefore, the hypothesis stated above is rejected.

The results support the finding of Shah (2004), Shian and Janice (2004).

It is indicated that students taught through Ausubel’s teaching strategy performed better than the students taught through traditional teaching strategy.
Figure 4.9 Data for the achievement scores of students in the subject of Physics (Practical) collected through Experimenter’s research tools ‘1 & 2’.
$H_{09}$. There is no significant difference between the total achievement scores of the students in the subject of Physics (Theory + Practical) taught through Ausubel and Traditional teaching strategies as measured by experimenter’s tool ‘1 and 2’.

Table 4.10

Overall achievement score of students in the subject of Physics (Theory + Practical) gain in the Experimenter’s research tools ‘1 & 2’.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausubelian Teaching Method (ATM)</td>
<td>31</td>
<td>95.9</td>
<td>29.4</td>
<td>4.10</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Traditional Teaching Method (TTM)</td>
<td>30</td>
<td>69.2</td>
<td>20.4</td>
<td>df = 59</td>
<td></td>
</tr>
</tbody>
</table>

The t-test was conducted to evaluate whether there was any significant difference between the overall (Theory + Practical) achievement scores of students in the subject of Physics taught through Ausubel and Traditional teaching strategies as measured by experimenter’s tool ‘1 and 2’. The result indicated that the mean concern for Ausuble’s teaching strategy ($M = 95.9$, $SD = 29.4$) was significantly greater than the mean concern for Traditional teaching strategy ($M = 69.2$ $SD = 20.4$), $t (59) = 4.10$.

The mean score of the experimental Group (95.9) is greater than the mean score of control group (69.2), it indicates that the difference in the achievement and attitude is significant, and is due to the treatment and is not by chance. Therefore, the hypothesis stated above is rejected.

The results support the finding of Shah (2004), Zaman (1996), Shian and Janice (2004).
It is indicated that students taught through Ausubel’s teaching strategy performed better than the students taught through traditional teaching strategy.

*Figure 4.10* Overall achievement score of students in the subject of Physics (Theory + Practical) gain in the Experimenter’s research tools ‘1 & 2’.
H_{010}. There is no significant difference between the achievement scores of students in the subject of Physics (Theory) taught through Ausubel’s and Traditional teaching strategies as measured by ‘First Term Test’.

Table 4.11

*Data for the achievement scores of students in the subject of Physics (Theory) collected through First Term Test.*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausubelian Teaching Method (ATM)</td>
<td>31</td>
<td>43.1</td>
<td>13.5</td>
<td>2.37</td>
<td>&lt; .05</td>
</tr>
<tr>
<td>Traditional Teaching Method (TTM)</td>
<td>30</td>
<td>35.2</td>
<td>12.6</td>
<td></td>
<td>df = 59</td>
</tr>
</tbody>
</table>

The t-test was conducted to evaluate whether there was any significant difference between the achievement scores of students in the subject of Physics (Theory) taught through Ausubel and Traditional teaching strategies as measured by First Term Test. The result indicated that the mean concern for Ausuble’s teaching strategy ($M = 43.1$, $SD = 13.5$) was significantly greater than the mean concern for Traditional teaching strategy ($M = 35.2$, $SD = 12.6$), $t(59) = 2.37$.

The mean score of the experimental Group (43.1) is greater than the mean score of control group (35.2), it indicates that the difference in the achievement is significant, and is due to the treatment and is not by chance. Therefore, the hypothesis stated above is rejected. The results of this study are consistent with the research studies presented in the literature review, such as Ausubel (1960), Ausubel (1978), Siddiqui (1993), Zaman (1996).

It is indicated that students taught through Ausubel’s teaching strategy performed better than the students taught through traditional teaching strategy.
Figure 4.11  Data for the achievement scores of students in the subject of Physics (Theory) collected through First Term Test.
There is no significant difference between the achievement scores of students in the subject of Physics (Practical) taught through Ausubel’s and Traditional teaching strategies as measured by ‘First Term Test’.

Table 4.12

*Data for the achievement scores of students in the subject of Physics (Practical) collected through First Term Test.*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausubelian Teaching Method (ATM)</td>
<td>31</td>
<td>15.1</td>
<td>4.6</td>
<td>3.16</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>Traditional Teaching Method (TTM)</td>
<td>30</td>
<td>11.6</td>
<td>4.1</td>
<td>df = 59</td>
<td></td>
</tr>
</tbody>
</table>

The t-test was conducted to evaluate whether there was any significant difference between the achievement scores of students in the subject of Physics (Practical) taught through Ausubel and Traditional teaching strategies as measured by First Term Test.

The result indicated that the mean concern for Ausubel’s teaching strategy ($M = 15.1$, $SD = 4.6$) was significantly greater than the mean concern for Traditional teaching strategy ($M = 11.6$, $SD = 4.1$), $t(59) = 3.16$. It is indicated that students taught through Ausubel’s teaching strategy performed better than the students taught through traditional teaching strategy.
Figure 4.12  Data for the achievement scores of students in the subject of Physics (Practical) collected through First Term Test.
H₀₁２. There is no significant difference between the achievement scores of students in the subject of Physics (Theory + Practical) taught through Ausubel’s and Traditional teaching strategies as measured by ‘First Term Test’.

Table 4.13

Summary of the achievement scores of students (Theory + Practical) collected through First Term Test in the subject of Physics.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausubelian Teaching Method</td>
<td>31</td>
<td>58.2</td>
<td>17.2</td>
<td>2.73</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>Traditional Teaching Method</td>
<td>30</td>
<td>46.7</td>
<td>15.6</td>
<td>df = 59</td>
<td></td>
</tr>
</tbody>
</table>

The t-test was conducted to evaluate whether there was any significant difference between the overall achievement scores of students in the subject of Physics (Theory + Practical) taught through Ausubel and Traditional teaching strategies as measured by First term test. The result indicated that the mean concern for Ausubel’s teaching strategy (M = 58.2, SD = 17.2) was significantly greater than the mean concern for Traditional teaching strategy (M = 46.7, SD = 15.6), t (59) = 2.73.

The mean score of the experimental Group (58.2) is greater than the mean score of control group (46.7), it indicates that the difference in the achievement is significant, and is due to the treatment and is not by chance. Therefore, the hypothesis stated above is rejected.

The results support the finding of Shah (2004), Shian and Janice (2004).

It is seen in the few research studies like Mayer (2003) that Ausubelian teaching method benefits average and slower learners and not those students who have in-depth knowledge about the content to be learned.
Figure 4.13 Data for the achievement scores of students in the subject of Physics (Theory + Practical) collected through First Term Test.
H_{0,13}. There is no significant difference between the achievement scores of students in the subject of Physics (Theory) taught through Ausubel’s and Traditional teaching strategies as measured by ‘Second Term Test’

Table 4.14

*Data for the achievement scores of students in the subject of Physics (theory) collected through Second Term Test.*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausubelian Teaching Method (ATM)</td>
<td>31</td>
<td>37.8</td>
<td>15.9</td>
<td>3.19</td>
<td>59</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>Traditional Teaching Method (TTM)</td>
<td>30</td>
<td>27.1</td>
<td>9.3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The t-test was conducted to evaluate whether there was any significant difference between the achievement scores of students in the subject of Physics (Theory) taught through Ausubel and Traditional teaching strategies as measured by Second Term Test. The result indicated that the mean concern for Ausubel’s teaching strategy \((M = 37.8, SD = 15.9)\) was significantly greater than the mean concern for Traditional teaching strategy \((M = 27.1, SD = 9.3)\), \(t(59) = 3.19\).

The mean score of the experimental Group (37.8) is greater than the mean score of control group (27.1), it indicates that the difference in the achievement is significant, and is due to the treatment and is not by chance. Therefore, the hypothesis stated above is rejected.

Although Ausubel’s (1960, 1966, 1978) has worked consistently to prove that his strategy facilitates learning. In the light of the findings of many research studies it is concluded that either advance organizers facilitate meaningful learning and beneficial for
the promotion of conceptual understanding of the students or the improvement in the learning is due to some other processes.

Figure 4.14 Data for the achievement scores of students in the subject of Physics (Theory) collected through Second Term Test.
$H_{014}$. There is no significant difference between the achievement scores of students in the subject of Physics (Practical) taught through Ausubel’s and Traditional teaching strategies as measured by ‘Second Term Test’.

Table 4.15

Data for the achievement scores of students in the subject of Physics (Practical) collected through Second Term Test.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausubelian Teaching Method (ATM)</td>
<td>31</td>
<td>17.8</td>
<td>2.4</td>
<td>3.42</td>
<td>59</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Traditional Teaching Method (TTM)</td>
<td>30</td>
<td>15.5</td>
<td>2.7</td>
<td>3.42</td>
<td>59</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>

The t-test was conducted to evaluate whether there was any significant difference between the achievement scores of students in the subject of Physics (Practical) taught through Ausubel and Traditional teaching strategies as measured by Second Term Test. The result indicated that the mean concern for Ausubel’s teaching strategy ($M = 17.8$, $SD = 2.4$) was significantly greater than the mean concern for Traditional teaching strategy ($M = 15.5$, $SD = 2.7$), $t (59) = 3.42$.

The mean score of the experimental Group (17.8) is greater than the mean score of control group (15.5), it indicates that the difference in the achievement is significant, and is due to the treatment and is not by chance. Therefore, the hypothesis stated above is rejected.

The results of this study are consistent with the research studies presented in the literature review, such as Ausubel (1960), Ausubel (1978), Siddiqui (1993), Zaman (1996), Novak (2001), Gupta (2004).
Figure 4.15  Data for the achievement scores of students in the subject of Physics (Practical) collected through Second Term Test.
There is no significant difference between the achievement scores of students in the subject of Physics (Theory + Practical) taught through Ausubel’s and Traditional teaching strategies as measured by ‘Second Term Test’.

Table 4.16

Data for the achievement scores of students in the subject of Physics (Theory+ Practical) collected through Second Term Test.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausubelian Teaching Method (ATM)</td>
<td>31</td>
<td>55.6</td>
<td>15.5</td>
<td>3.87</td>
<td>59</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Traditional Teaching Method (TTM)</td>
<td>30</td>
<td>42.6</td>
<td>9.9</td>
<td>3.87</td>
<td>59</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>

The t-test was conducted to evaluate whether there was any significant difference between the overall (Theory + Practical) achievement scores of students in the subject of Physics taught through Ausubel and Traditional teaching strategies as measured by Second Term Test. The result indicated that the mean concern for Ausubel’s teaching strategy ($M = 55.6$, $SD = 15.5$) was significantly greater than the mean concern for Traditional teaching strategy ($M = 42.6$, $SD 9.9$), $t (59) = 3.874$. It is indicated that students taught through Ausubel’s teaching strategy performed better than the students taught through traditional teaching strategy.

The study is consistent with the views of Ausubel (1960), Ausubel (1978): specifically the importance of pre-learning.
Figure 4.16  Data for the achievement scores of students in the subject of Physics (Theory + Practical) collected through Second Term Test.
There is no significant difference between the total achievement scores of the students in the subject of Physics (Theory) taught through Ausubel and Traditional teaching strategies as measured by First and Second Term Test.

Table 4.17

Data for the achievement scores of students in the subject of Physics (Theory) collected through First and Second Term Test.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausubelian Teaching Method (ATM)</td>
<td>31</td>
<td>80.9</td>
<td>25.8</td>
<td>3.24</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>Traditional Teaching Method (TTM)</td>
<td>30</td>
<td>62.2</td>
<td>18.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The t-test was conducted to evaluate whether there was any significant difference between the overall achievement scores of students in the subject of Physics (Theory) taught through Ausubel and Traditional teaching strategies as measured by First and Second Term Test. The result indicated that the mean concern for Ausuble’s teaching strategy ($M = 80.9, SD = 25.8$) was significantly greater than the mean concern for Traditional teaching strategy ($M = 62.2, SD = 18.5$), $t(59) = 3.24$. The calculated t-value (3.24) is greater than the tabulated t-value (2.04); this shows a significant difference between the performance of the experimental and control groups. Therefore, the hypothesis stated above is rejected. It is concluded that students taught through Ausubel’s teaching strategy performed better than the students taught through traditional teaching strategy.

The results of this study were consistent with the findings of Kinchin (2000), Lewis (1987) that the Ausubel’s teaching strategies found to enhance significantly the conceptual understanding of the students.
Ausubel’s teaching strategies has been found to be equally effective to traditional strategies in terms of achievement by Woodward (1985), Carnes (1985).

**Figure 4.17**   Data for the achievement scores of students in the subject of Physics (Theory) collected through First and Second Term Test.
There is no significant difference between the total achievement scores of the students in the subject of Physics (Practical) taught through Ausubel and Traditional teaching strategies as measured by First and Second Term Test.

Table 4.18

Data for the achievement scores of students in the subject of Physics (Practical) collected through First and Second Term Test.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausubelian Teaching Method (ATM)</td>
<td>31</td>
<td>32.9</td>
<td>5.4</td>
<td>4.30</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Traditional Teaching Method (TTM)</td>
<td>30</td>
<td>27.1</td>
<td>5.1</td>
<td>df = 59</td>
<td>.001</td>
</tr>
</tbody>
</table>

The t-test was applied to evaluate whether there was any significant difference between the overall achievement scores of students in the subject of Physics (Practical) taught through Ausubel and Traditional teaching strategies as measured by First and Second Term Test. The result indicated that the mean concern for Ausuble’s teaching strategy ($M = 32.9$, $SD = 5.4$) was significantly greater than the mean concern for Traditional teaching strategy ($M = 27.1$, $SD = 5.1$), $t (59) = 4.30$. As the calculated t-value (4.30) is greater than the tabulated t-value (2.04), this shows a significant difference between the performance of the experimental and control groups. Therefore, the hypothesis “There is no significant difference between the total achievement scores of the students in the subject of Physics (Practical) taught through Ausubel and Traditional teaching strategies as measured by First and Second Term Test” is rejected.
Figure 4.18  Data for the achievement scores of students in the subject of Physics (Practical) collected through First and Second Term Test.
There is no significant difference between the total achievement scores of the students in the subject of Physics (Theory + Practical) taught through Ausubel and Traditional teaching strategies as measured by First and Second Term Test.

**Table 4.19**

*Overall achievement score of students in the subject of Physics (Theory + Practical) gain in the First and Second Term Test.*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausubelian Teaching Method (ATM)</td>
<td>31</td>
<td>113.8</td>
<td>28.5</td>
<td>3.77</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Traditional Teaching Method (TTM)</td>
<td>30</td>
<td>89.4</td>
<td>21.5</td>
<td>df = 59</td>
<td></td>
</tr>
</tbody>
</table>

The t-test was conducted to evaluate whether there was any significant difference between the overall achievement scores of students in the subject of Physics taught through Ausubel and Traditional Teaching Strategies as measured by Second Term Test. The result indicated that the mean concern for Ausubel’s teaching strategy ($M = 113.8$, $SD = 28.5$) was significantly greater than the mean concern for Traditional teaching strategy ($M = 89.4$, $SD = 21.5$), $t (59) = 3.77$. The results indicated that students taught through Ausubel’s teaching strategy performed better than the students taught through traditional teaching strategy.

The results of this study were mostly in line with those of previous researches carried out in other region/cultures such as Anderson (1973), Rajoriya (1986), Mayer (2003), found that ATS to be useful strategy for teaching new concepts when the students do not have previous knowledge of a concept.
Figure 4.19  Overall achievement score of students in the subject of Physics (Theory + Practical) gain in the First and Second Term Test.
There is no significant difference between the achievement scores of the students in the subject of physics (theory and practical) by the use of Ausubel’s and Traditional teaching strategies in the Secondary School Certificate (SSC) Examination conducted by the Board of Intermediate and Secondary Education (BISE) Rawalpindi (Annual 2005)

Table 4.20

Students overall (theory and practical) achievement scores in the subject of physics as measured in the Secondary School Certificate (SSC) examination Annual 2005, when taught through ATS and TTS.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausubelian Teaching Method (ATM)</td>
<td>31</td>
<td>57.2</td>
<td>18.6</td>
<td>2.95</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>Traditional Teaching Method (TTM)</td>
<td>30</td>
<td>44.4</td>
<td>15.1</td>
<td>df = 59</td>
<td></td>
</tr>
</tbody>
</table>

A independent sample t-test was conducted to evaluate whether there was any significant difference between the overall (Theory + Practical) achievement scores of students in the subject of Physics taught through Ausubel and Traditional teaching strategies as measured by experimenter’s tool. The result indicated that the mean concern for Ausubel’s teaching strategy ($M = 57.2$, $SD = 18.6$) was significantly greater than the mean concern for Traditional teaching strategy ($M = 44.4$, $SD = 15.1$), $t (59) = 2.95$. Therefore, the hypothesis stated above is rejected.

It is indicated that students taught through Ausubel’s teaching strategy performed better than the students taught through traditional teaching strategy.

The result of the study is consistent with the views of Ausubel (1960): specifically the importance of pre-learning, the linking of new ideas to previous knowledge.
Same results are evidenced by the researches conducted by Rajoriya (1987), Lewis (1987), Ausubel & Gait (1968), Ausubel (1978), Siddiqui (1993), Novak (2001), who compared meaningful learning model /advance organizer model with traditional methods for teaching and has been found that advance organizer model facilitated significantly higher learning in comparison to traditional method.

There are some researches which showed no difference in the two strategies e.g. Moore (1975), Carness (1985).

There are also a few studies like Tennyson (1986), which found traditional teaching strategy superior to Ausubel in terms of students’ achievement. The study of Tennyson shows interesting result but this study was of shorter duration and covered very small content.
Figure 4.20  Means, SDs and ‘t’-value for the students overall (theory and practical) achievement scores in the subject of physics and measured in the secondary school certificate (SSC) examination Annual 2005, when taught through ATS and TTS.
There is no significant different between the achievement scores of the students in the subject of physics theory as measured by the use of Asubel’s and Traditional Teaching Strategies in the SSC examination conducted by the BISE Rawalpindi (Annual 2005).

Table 4.21

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausubelian Teaching</td>
<td>31</td>
<td>36.5</td>
<td>17.1</td>
<td>2.62</td>
<td>&lt; .05</td>
</tr>
<tr>
<td>Method (ATM)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional Teaching</td>
<td>30</td>
<td>25.9</td>
<td>14.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Method (TTM)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

An independent sample t-test was conducted to evaluate whether there was any significant difference between the achievement scores of students in the subject of Physics (theory) taught through Ausubel and Traditional teaching strategies as measured by SSC annual examination 2005. The result indicated that the mean concern for Ausuble’s teaching strategy ($M = 36.5$, $SD = 17.1$) was significantly greater than the mean concern for Traditional teaching strategy ($M = 25.9$, $SD = 14.2$), $t (59) = 2.62$. The above mentioned results show the improvement in favour of Ausubel’s teaching strategy when compared with traditional teaching strategy.

These results support the findings of Ausubel & Youssef (1963), Pandey (1986), Shian (2004).
Figure 4.21  Means, SDs and ‘t’-value for the students’ achievement scores in the subject of Physics theory as measured in the SSC annual examination 2005, taught through ATS and TTS.
There is no significant difference between the achievement scores of the students in the subject of physics practical as measured by the use of Ausubel’s and Traditional teaching strategies in the SSC examination conducted by the BISE Rawalpindi (Annual 2005).

Table 4.22

*Student’s achievement scores in the subject of Physics practical as measured in the SSC annual examination 2005, taught through ATS and TTS.*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ausubelian Teaching Method (ATM)</td>
<td>31</td>
<td>20.7</td>
<td>2.3</td>
<td>3.75</td>
<td>&lt; .001</td>
</tr>
<tr>
<td>Traditional Teaching Method (TTM)</td>
<td>30</td>
<td>18.5</td>
<td>2.3</td>
<td>3.75 (df = 59)</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>

An independent sample t-test was conducted to evaluate whether there was any significant difference between the achievement scores of students in the subject of Physics practical taught through Ausubel and Traditional teaching strategies as measured by SSC annual examination 2005. The result indicated that the mean concern for Ausubel’s teaching strategy ($M = 20.7, \text{SD} = 2.3$) was significantly greater than the mean concern for Traditional teaching strategy ($M = 18.5, \text{SD} = 2.3$), $t(59) = 3.75$. Therefore, the hypothesis stated above is rejected.

These results support the findings of Ausubel and Youssef (1963) that the performance of the advance organizer group was significantly higher at 0.05 level. To have further insight into the difference of means of achievement scores in the above table, the comparison is presented as histogram and is shown below.
Figure 4.22  Means, SDs and ‘t’-value for the student’s achievement scores in the subject of Physics practical as measured in the SSC annual examination 2005, taught through ATS and TTS.
Second Objective

Find out the effects of pre-lab on the learning of the students in the physical science laboratory.

$H_{022}$: There is no significant difference between the achievement of the students with pre-lab (experimental group) and students without pre-lab (control group) in the post labs results.
Table 4.23

Summary of the post-lab results of experimental and control groups

<table>
<thead>
<tr>
<th>Laboratory Experiments</th>
<th>Experimental (with pre-lab)</th>
<th>Control (without pre-lab)</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 31</td>
<td>N = 30</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td><strong>SD</strong></td>
<td><strong>Mean</strong></td>
<td><strong>SD</strong></td>
</tr>
<tr>
<td>1. Diameter of a solid cylinder</td>
<td>5.5</td>
<td>4.5</td>
<td>1.9</td>
</tr>
<tr>
<td>2. Thickness of a given wire</td>
<td>6.5</td>
<td>4.1</td>
<td>1.6</td>
</tr>
<tr>
<td>3. Acceleration of a body</td>
<td>5.8</td>
<td>4.7</td>
<td>1.7</td>
</tr>
<tr>
<td>4. M.A of an inclined Plane</td>
<td>5.1</td>
<td>3.8</td>
<td>1.4</td>
</tr>
<tr>
<td>5. Principle of moments</td>
<td>5.9</td>
<td>5.1</td>
<td>2.2</td>
</tr>
<tr>
<td>6. Resultant of two vectors</td>
<td>6.7</td>
<td>4.4</td>
<td>1.7</td>
</tr>
<tr>
<td>7. Verify Hook’s Law</td>
<td>6.6</td>
<td>5.7</td>
<td>1.2</td>
</tr>
<tr>
<td>8. Density of a body</td>
<td>5.8</td>
<td>5.7</td>
<td>1.3</td>
</tr>
<tr>
<td>9. Simple pendulum</td>
<td>6.8</td>
<td>4.5</td>
<td>1.2</td>
</tr>
<tr>
<td>10. Speed of sound</td>
<td>6.3</td>
<td>5.5</td>
<td>1.1</td>
</tr>
<tr>
<td>11. Verify Ohm’s law</td>
<td>5.9</td>
<td>5.0</td>
<td>1.3</td>
</tr>
<tr>
<td>12. Plot Magnetic field</td>
<td>6.4</td>
<td>5.6</td>
<td>1.7</td>
</tr>
<tr>
<td>13. Density of solid heavier than water</td>
<td>6.1</td>
<td>4.9</td>
<td>1.3</td>
</tr>
<tr>
<td>14. Characteristics of P-N junction</td>
<td>5.9</td>
<td>5.2</td>
<td>1.1</td>
</tr>
<tr>
<td>15. Truth table of AND &amp; OR gates</td>
<td>7.6</td>
<td>6.2</td>
<td>1.4</td>
</tr>
<tr>
<td>16. Laws of Reflection</td>
<td>5.9</td>
<td>5.0</td>
<td>1.2</td>
</tr>
<tr>
<td>17. Laws of Refraction</td>
<td>6.4</td>
<td>5.6</td>
<td>1.7</td>
</tr>
<tr>
<td>18. Focal length of a concave mirror</td>
<td>6.1</td>
<td>4.9</td>
<td>1.3</td>
</tr>
<tr>
<td>19. Focal length of a convex Lens</td>
<td>5.9</td>
<td>5.2</td>
<td>1.1</td>
</tr>
<tr>
<td>20. Critical angle of glass</td>
<td>7.7</td>
<td>6.3</td>
<td>1.4</td>
</tr>
</tbody>
</table>
Table 4.23 shows the statistics of twenty experiments exploring the effect of pre-lab on the learning of the students. Results revealed that the experimental group outperformed in the post-lab results as compared to the control group in almost all the experiments except No. 5 & 8, in the subject of physics. It is concluded from the above table that pre-lab effects positively to enhance the learning of the students in the subject of Physics at secondary level. As the mean of the experimental group is significantly higher than the control group, it is indicated that the difference is not by chance. Therefore, the hypothesis stated above is rejected.

Literature reviewed showed almost same results as evidenced by the researches conducted by Zaman (1996), Johnstone and Zaman (1998), and some others but mostly at university level. This study is specifically consistent with the findings of Shah (2004) and Limniou (2008). Since the results are consistent with the results of the above cited researches, hence, we concluded that the pre-labs help the students in improving the performance of student in the physical science laboratory.

It is also very interesting that the standard deviation of the students with pre-lab (Experimental Group) is high which shows that some students learn more and some learn least. This gives rise to the idea of student learning style, (convergent / divergent, field dependence / field independence etc) which should be explored in future.
Figure 4.23

Comparison of Post-lab Results of Experimental & Control Groups

Figure 4.24
Comparison of S.D of the Experimental and Control Groups
(Post Lab Results)
The discussion of each post lab is presented below:

Table 4.23.1

*Mean score achieved by the students with pre-lab and students without pre-lab in the experiment, “Determine the diameter of the solid cylinder with the help of Vernier Callipers.”*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Pre-lab</td>
<td>31</td>
<td>5.5</td>
<td>1.9</td>
<td>2.02</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Students without Pre-lab</td>
<td>30</td>
<td>4.5</td>
<td>1.9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.23.1 shows that the difference between the mean scores of the students with pre-lab (experimental group) and the students without pre-lab (control group) in the post test was found significant at 0.01 level.

As our calculated value of t (t = 2.02) is greater than the tabulate value of t (t = 2.009). Hence, the null hypothesis, “there is no significant difference between the achievement of the students with pre-lab and students without pre-lab in the post labs results” was rejected.

The post lab performance of the experimental group (students with pre-lab) was differed significantly than the control group (student without pre-lab). The results are consistent with the finding of Zaman (1996) who discovered that students appeared to be better suited to learning when they came in the lab with some prior knowledge related to the actual practical work to be done. The above results are congruent with the findings of Shah (2004).
Figure 4.23.1 Mean score achieved by the students with pre-lab and students without pre-lab in the experiment “Determine the diameter of the solid cylinder with the help of Vernier Callipers.”
Table 4.23.2

Mean score achieved by the students with pre-lab and students without pre-lab in the experiment, “Determine the thickness of a given wire by using a screw gauge and calculate its area of cross-section”.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Pre-lab</td>
<td>31</td>
<td>6.51</td>
<td>1.69</td>
<td>5.577</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Students without Pre-lab</td>
<td>30</td>
<td>4.13</td>
<td>1.63</td>
<td>df=59</td>
<td></td>
</tr>
</tbody>
</table>

A paired sample t-test was conducted to evaluate whether there was any significant difference between the mean score achieved by the students with pre-lab and without pre-lab. The result indicated that the mean concern for Students with pre-lab ($M = 5.54$, $SD = 1.94$) was significantly greater than the mean concern for Students without pre-lab ($M = 4.56$, $SD = 1.85$), $t$ (59) = 2.017. It is indicated that students with pre-lab performed better than the students without pre-lab.

This work is in line with the majority of the previous studies, resulted in favour of pre-lab. The superiority of this approach could be attributed to the active participation of students in all processes of learning in the laboratory. This develops a positive attitude toward the physics, and consequently results in high performance.

Conversely, expecting students to engage in laboratory activities without some form of prior consideration may leave them feeling insecure, and result in a rather poor understanding of what is happening. Students often have difficulty in completing the necessary calculations relevant to the experiment and results in poor performance.
Figure 4.23.2  Mean score achieved by the students with pre-lab and students without pre-lab in the experiment “Determine the thickness of a given wire by using a screw gauge and calculate its area of cross-section”.

![Bar chart showing mean scores with and without pre-lab](image-url)
Table 4.23.3

Mean score achieved by the students with pre-lab and students without pre-lab in the experiment, “Find the acceleration of a body placed on an angle iron”.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Pre-lab</td>
<td>31</td>
<td>5.80</td>
<td>1.91</td>
<td>2.30</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Students without Pre-lab</td>
<td>30</td>
<td>4.75</td>
<td>1.65</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A paired sample t-test was conducted to evaluate whether there was any significant difference between the mean score achieved by the students with pre-lab and without pre-lab. The result indicated that the mean concern for Students with pre-lab (\(M = 5.80, SD = 1.80\)) was significantly greater than the mean concern for Students without pre-lab (\(M = 4.75, SD = 1.65\)), \(t(59) = 2.30\). It is indicated that students with pre-lab performed better than the students without pre-lab.
Figure 4.23.3 Mean score achieved by the students with pre-lab and students without pre-lab in the experiment “Find the acceleration of a body placed on an angle iron”.

![Bar chart showing scores for students with and without pre-lab]
Table 4.23.4

*Mean score achieved by the students with pre-lab and students without pre-lab in the experiment, “Find the mechanical advantage of an inclined plane”.*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Pre-lab</td>
<td>31</td>
<td>5.12</td>
<td>1.73</td>
<td>3.078</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Students without Pre-lab</td>
<td>30</td>
<td>3.88</td>
<td>1.40</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A paired sample t-test was conducted to evaluate whether there was any significant difference between the mean score achieved by the students with pre-lab and without pre-lab. The result indicated that the mean concern for Students with pre-lab (\(M = 5.12, SD = 1.73\)) was significantly greater than the mean concern for Students without pre-lab (\(M = 3.88, SD = 1.40\)), \(t(59) = 3.078\). It is indicated that students with pre-lab performed better than the students without pre-lab.
Figure 4.23.4  Mean score achieved by the students with pre-lab and students without pre-lab in the experiment “Find the mechanical advantage of an inclined plane”.

![Bar chart showing the mean score achieved by students with and without pre-lab in the experiment](chart.png)
Table 4.23.5

*Mean score achieved by the students with pre-lab and students without pre-lab in the experiment, “Study the principle of moments.”*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Pre-lab</td>
<td>31</td>
<td>5.96</td>
<td>2.00</td>
<td>1.76</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Students without Pre-lab</td>
<td>30</td>
<td>5.07</td>
<td>2.20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A paired sample t-test was conducted to evaluate whether there was any significant difference between the mean score achieved by the students with pre-lab and without pre-lab. The result indicated that the mean concern for Students with pre-lab (M = 5.96, SD = 2.00) was significantly greater than the mean concern for Students without pre-lab (M = 5.07, SD = 2.20), t (59) = 1.76. It is indicated that students with pre-lab performed better than the students without pre-lab.
Figure 4.23.5  Mean score achieved by the students with pre-lab and students without pre-lab in the experiment “Study the principle of moments.”
Table 4.23.6

Mean score achieved by the students with pre-lab and students without pre-lab in the experiment, “Find the resultant of two vectors by graphic method.”

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Pre-lab</td>
<td>31</td>
<td>6.77</td>
<td>1.60</td>
<td>5.57</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Students without Pre-lab</td>
<td>30</td>
<td>4.41</td>
<td>1.69</td>
<td>df=59</td>
<td></td>
</tr>
</tbody>
</table>

A paired sample t-test was conducted to evaluate whether there was any significant difference between the mean score achieved by the students with pre-lab and without pre-lab. The result indicated that the mean concern for Students with pre-lab ($M = 6.77$, $SD = 1.60$) was significantly greater than the mean concern for Students without pre-lab ($M = 4.41$, $SD = 1.69$), $t(59) = 5.57$. It is indicated that students with pre-lab performed better than the students without pre-lab.
**Figure 4.23.6** Mean score achieved by the students with pre-lab and students without pre-lab in the experiment “Find the resultant of two vectors by graphic method.”
Table 4.23.7

*Mean score achieved by the students with pre-lab and students without pre-lab in the experiment, “Verify Hook’s Law.”*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Pre-lab</td>
<td>31</td>
<td>6.64</td>
<td>1.74</td>
<td>2.55</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Students without Pre-lab</td>
<td>30</td>
<td>5.66</td>
<td>1.18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A paired sample t-test was conducted to evaluate whether there was any significant difference between the mean score achieved by the students with pre-lab and without pre-lab. The result indicated that the mean concern for Students with pre-lab ($M = 6.64$, $SD = 1.74$) was significantly greater than the mean concern for Students without pre-lab ($M = 5.66$, $SD = 1.18$), $t$ (59) = 2.55. It is indicated that students with pre-lab performed better than the students without pre-lab.
Figure 4.23.7 Mean score achieved by the students with pre-lab and students without pre-lab in the experiment “Verify Hook’s Law.”
Table 4.23.8

Mean score achieved by the students with pre-lab and students without pre-lab in the experiment, “Find the density of a body by using Archimedes principle”.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Pre-lab</td>
<td>31</td>
<td>5.80</td>
<td>1.49</td>
<td>0.20</td>
<td>&gt;.05</td>
</tr>
<tr>
<td>Students without Pre-lab</td>
<td>30</td>
<td>5.73</td>
<td>1.25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A paired sample t-test was conducted to evaluate whether there was any significant difference between the mean score achieved by the students with pre-lab and without pre-lab. The result indicated that the mean concern for Students with pre-lab (M = 5.80, SD = 1.49) was significantly greater than the mean concern for Students without pre-lab (M = 5.73, SD = 1.25), t (59) = .20. It is indicated that students with pre-lab performed better than the students without pre-lab.
Figure 4.23.8  Mean score achieved by the students with pre-lab and students without pre-lab in the experiment “Find the density of a body by using Archimedes principle”.

![Bar chart showing mean scores with and without pre-lab](chart.png)
Table 4.23.9

*Mean score achieved by the students with pre-lab and students without pre-lab in the experiment, “Study the effect of length of a simple pendulum on the time period, and also find the value of ‘g’. Is it 9.8m/s?”*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Pre-lab</td>
<td>31</td>
<td>6.64</td>
<td>1.49</td>
<td>1.27</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Students without Pre-lab</td>
<td>30</td>
<td>6.20</td>
<td>1.21</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A paired sample t-test was conducted to evaluate whether there was any significant difference between the mean score achieved by the students with pre-lab and without pre-lab. The result indicated that the mean concern for Students with pre-lab (M = 6.64, SD = 1.49) was significantly greater than the mean concern for Students without pre-lab (M = 6.20, SD = 1.21), t (59) = 1.27. It is indicated that students with pre-lab performed better than the students without pre-lab.
Figure 4.23.9 Mean score achieved by the students with pre-lab and students without pre-lab in the experiment “Study the effect of length of a simple pendulum on the time period, and also find the value of ‘g’. Is it 9.8m/s?”
Table 4.23.10

Mean score achieved by the students with pre-lab and students without pre-lab in the experiment, “Determine the speed of sound at room temperature by using a resonance tube.”

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>df=59</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Pre-lab</td>
<td>31</td>
<td>6.32</td>
<td>1.55</td>
<td>2.25</td>
<td>&lt;.05</td>
<td></td>
</tr>
<tr>
<td>Students without Pre-lab</td>
<td>30</td>
<td>6.20</td>
<td>1.13</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A paired sample t-test was conducted to evaluate whether there was any significant difference between the mean score achieved by the students with pre-lab and without pre-lab. The result indicated that the mean concern for Students with pre-lab (M = 6.32, SD = 1.55) was significantly greater than the mean concern for Students without pre-lab (M = 6.20, SD = 1.13), t (59) = 2.25. It is indicated that students with pre-lab performed better than the students without pre-lab.
Figure 4.23.10  Mean score achieved by the students with pre-lab and students without pre-lab in the experiment “Determine the speed of sound at room temperature by using a resonance tube.”
Table 4.23.11

*Mean score achieved by the students with pre-lab and students without pre-lab in the experiment, “Verify Ohm’s Law/Study the relationship between current and voltage, also plot the graph between the two variables.”*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Pre-lab</td>
<td>31</td>
<td>5.90</td>
<td>1.32</td>
<td>2.72</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Students without Pre-lab</td>
<td>30</td>
<td>5.00</td>
<td>1.25</td>
<td>df=59</td>
<td></td>
</tr>
</tbody>
</table>

A paired sample t-test was conducted to evaluate whether there was any significant difference between the mean score achieved by the students with pre-lab and without pre-lab. The result indicated that the mean concern for Students with pre-lab (M = 5.90, SD = 1.32) was significantly greater than the mean concern for Students without pre-lab (M = 5.00, SD = 1.25), t (59) = 2.72. It is indicated that students with pre-lab performed better than the students without pre-lab.
Figure 4.23.11 Mean score achieved by the students with pre-lab and students without pre-lab in the experiment “Verify Ohm’s Law/Study the relationship between current and voltage, also plot the graph between the two variables.”

![Bar Chart](image)
Table 4.23.12

Mean score achieved by the students with pre-lab and students without pre-lab in the experiment, “Plot the magnetic field (magnetic lines of forces) due to a bar magnet.”

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Pre-lab</td>
<td>31</td>
<td>6.37</td>
<td>1.30</td>
<td>2.03</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Students without Pre-lab</td>
<td>30</td>
<td>5.60</td>
<td>1.69</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A paired sample t-test was conducted to evaluate whether there was any significant difference between the mean score achieved by the students with pre-lab and without pre-lab. The result indicated that the mean concern for Students with pre-lab ($M = 6.37$, $SD = 1.30$) was significantly greater than the mean concern for Students without pre-lab ($M = 5.60$, $SD = 1.69$), $t(59) = 2.03$. It is indicated that students with pre-lab performed better than the students without pre-lab.
Figure 4.23.12 Mean score achieved by the students with pre-lab and students without pre-lab in the experiment “Plot the magnetic field (magnetic lines of forces) due to a bar magnet.”
Table 4.23.13

Mean score achieved by the students with pre-lab and students without pre-lab in the experiment, “Find the center of gravity of an irregular shaped card.”

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Pre-lab</td>
<td>31</td>
<td>6.06</td>
<td>1.50</td>
<td>3.18</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Students without Pre-lab</td>
<td>30</td>
<td>4.93</td>
<td>1.25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A paired sample t-test was conducted to evaluate whether there was any significant difference between the mean score achieved by the students with pre-lab and without pre-lab. The result indicated that the mean concern for Students with pre-lab (M = 6.06, SD = 1.50) was significantly greater than the mean concern for Students without pre-lab (M = 4.93, SD = 1.25), t (59) = 3.18. It is indicated that students with pre-lab performed better than the students without pre-lab.
Figure 4.23.13 Mean score achieved by the students with pre-lab and students without pre-lab in the experiment “Find the center of gravity of an irregular shaped card.”
Table 4.23.14

*Mean score achieved by the students with pre-lab and students without pre-lab in the experiment, “Find the value of ‘g’ by free fall method.”*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Pre-lab</td>
<td>31</td>
<td>5.87</td>
<td>1.45</td>
<td>2.01</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Students without Pre-lab</td>
<td>30</td>
<td>5.20</td>
<td>1.12</td>
<td>2.01</td>
<td>&lt;.05</td>
</tr>
</tbody>
</table>

A paired sample t-test was conducted to evaluate whether there was any significant difference between the mean score achieved by the students with pre-lab and without pre-lab. The result indicated that the mean concern for Students with pre-lab (M = 5.87, SD = 1.45) was significantly greater than the mean concern for Students without pre-lab (M = 5.20, SD = 1.12), t (59) = 2.01. It is indicated that students with pre-lab performed better than the students without pre-lab.
Figure 4.23.14  Mean score achieved by the students with pre-lab and students without pre-lab in the experiment “Find the value of ‘g’ by free fall method.”
Table 4.23.15

*Mean score achieved by the students with pre-lab and students without pre-lab in the experiment, “Determine the mechanical advantage and efficiency of a simple fixed pulley.”*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Pre-lab</td>
<td>31</td>
<td>7.63</td>
<td>1.40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students without Pre-lab</td>
<td>30</td>
<td>6.26</td>
<td>1.36</td>
<td>3.79</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

A paired sample t-test was conducted to evaluate whether there was any significant difference between the mean score achieved by the students with pre-lab and without pre-lab. The result indicated that the mean concern for Students with pre-lab (\(M = 7.63, SD = 1.40\)) was significantly greater than the mean concern for Students without pre-lab (\(M = 6.26, SD = 1.36\)), \(t\) (59) = 3.79. It is indicated that students with pre-lab performed better than the students without pre-lab.
Figure 4.23.15  Mean score achieved by the students with pre-lab and students without pre-lab in the experiment “Determine the mechanical advantage and efficiency of a simple fixed pulley.”
Table 4.23.16

*Mean score achieved by the students with pre-lab and students without pre-lab in the experiment, “Verify the laws of reflection of light.”*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Pre-lab</td>
<td>31</td>
<td>5.93</td>
<td>1.32</td>
<td>2.72</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Students without Pre-lab</td>
<td>30</td>
<td>5.00</td>
<td>1.25</td>
<td>df=59</td>
<td></td>
</tr>
</tbody>
</table>

A paired sample t-test was conducted to evaluate whether there was any significant difference between the mean score achieved by the students with pre-lab and without pre-lab. The result indicated that the mean concern for Students with pre-lab ($M = 5.93$, $SD = 1.32$) was significantly greater than the mean concern for Students without pre-lab ($M = 5.00$, $SD = 1.25$), $t (59) = 2.72$. It is indicated that students with pre-lab performed better than the students without pre-lab.
Figure 4.23.16  Mean score achieved by the students with pre-lab and students without pre-lab in the experiment “Verify the laws of reflection of light.”
Table 4.23.17

*Mean score achieved by the students with pre-lab and students without pre-lab in the experiment, “Study the laws of refraction of light by using glass slab.”*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Pre-lab</td>
<td>31</td>
<td>6.38</td>
<td>1.30</td>
<td>2.03</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Students without Pre-lab</td>
<td>30</td>
<td>5.60</td>
<td>1.69</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A paired sample t-test was conducted to evaluate whether there was any significant difference between the mean score achieved by the students with pre-lab and without pre-lab. The result indicated that the mean concern for Students with pre-lab (M = 6.38, SD = 1.30) was significantly greater than the mean concern for Students without pre-lab (M = 5.60, SD = 1.69), t (59) = 2.03. It is indicated that students with pre-lab performed better than the students without pre-lab.
Figure 4.23.17 Mean score achieved by the students with pre-lab and students without pre-lab in the experiment “Study the laws of refraction of light by using glass slab.”
Table 4.23.18

Mean score achieved by the students with pre-lab and students without pre-lab in the experiment, “Determine the focal length of a concave mirror by parallel method using one needle.”

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Pre-lab</td>
<td>31</td>
<td>6.06</td>
<td>1.50</td>
<td>3.18</td>
<td>&lt;.01</td>
</tr>
<tr>
<td>Students without Pre-lab</td>
<td>30</td>
<td>4.93</td>
<td>1.25</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A paired sample t-test was conducted to evaluate whether there was any significant difference between the mean score achieved by the students with pre-lab and without pre-lab. The result indicated that the mean concern for Students with pre-lab ($M = 6.06$, $SD = 1.50$) was significantly greater than the mean concern for Students without pre-lab ($M = 4.93$, $SD = 1.25$), $t$ (59) = 3.18. It is indicated that students with pre-lab performed better than the students without pre-lab.
Figure 4.23.18  Mean score achieved by the students with pre-lab and students without pre-lab in the experiment “Determine the focal length of a concave mirror by parallel method using one needle.”
Table 4.23.19

*Mean score achieved by the students with pre-lab and students without pre-lab in the experiment, “Determine the focal length of a convex lens by two-pin method.”*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Pre-lab</td>
<td>31</td>
<td>5.87</td>
<td>1.45</td>
<td>2.01</td>
<td>&lt;.05</td>
</tr>
<tr>
<td>Students without Pre-lab</td>
<td>30</td>
<td>5.20</td>
<td>1.12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A paired sample t-test was conducted to evaluate whether there was any significant difference between the mean score achieved by the students with pre-lab and without pre-lab. The result indicated that the mean concern for Students with pre-lab ($M = 5.87$, $SD = 1.45$) was significantly greater than the mean concern for Students without pre-lab ($M = 5.20$, $SD = 1.12$), $t(59) = 2.01$. It is indicated that students with pre-lab performed better than the students without pre-lab.
Figure 4.23.19 Mean score achieved by the students with pre-lab and students without pre-lab in the experiment “Determine the focal length of a convex lens by two-pin method.”
Table 4.23.20

*Mean score achieved by the students with pre-lab and students without pre-lab in the experiment, “Determine the critical angle of glass using a glass prism and calculate the refractive index of material of the prism.*

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students with Pre-lab</td>
<td>31</td>
<td>7.61</td>
<td>1.40</td>
<td>3.79</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Students without Pre-lab</td>
<td>30</td>
<td>6.26</td>
<td>1.36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A paired sample t-test was conducted to evaluate whether there was any significant difference between the mean score achieved by the students with pre-lab and without pre-lab. The result indicated that the mean concern for Students with pre-lab (M = 7.61, SD = 1.40) was significantly greater than the mean concern for Students without pre-lab (M = 6.26, SD = 1.36), t(59) = 3.79. It is indicated that students with pre-lab performed better than the students without pre-lab.
Figure 4.23.20  Mean score achieved by the students with pre-lab and students without pre-lab in the experiment “Determine the critical angle of glass using a glass prism and calculate the refractive index of material of the prism.
The third objective

To compare the scientific attitude as developed by Ausubel’s Teaching Strategy and Traditional Teaching Strategy among the secondary school science students.

H₀: There is no significant difference between the scientific attitude of the experimental and control group.

Table 4.24

Data regarding to the marks achieved by the sample students in the attitude scale.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>t-value</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>31</td>
<td>115.3</td>
<td>15.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>30</td>
<td>102.5</td>
<td>15.4</td>
<td>3.29</td>
<td>&lt; .01</td>
</tr>
</tbody>
</table>

The t-test was applied to evaluate whether there was any significant difference between the mean score achieved by the students in the attitude scale. The results indicated that the mean concern of the experimental group (M = 115.3, SD = 15.2) was significantly greater than the mean concern for control group (M = 102.5, SD = 15.4), t(59) = 3.29. This shows that there is a significant gain in attitude scores of students when taught through Ausubel’s Teaching Strategy. It indicates that the difference in attitude is not by chance. Therefore, the hypothesis stated above is rejected.

Results of the study presented in the above table are consistent with the views of Morgan (1985), he found the facilitating effects of advance organizers on both students’ achievement and students’ attitudes.

Pandey, (1986) reported advance organizer teaching strategy to be superior to traditional in terms of educational achievement while they were found equally effective in terms of attitude.
Fourth objective
To correlate the attitude scale scores and the achievement scores of the sample students.

H₀₂₄. There is no relationship between the marks achieved by the students in the Secondary School Certificate Examination 2005 conducted by the Educational Board and the attitude scale scores of the experimental and control groups.

Table 4.25

Data regarding the correlation between the marks achieved by the experimental and control groups in the SSC Examination Annual 2005 and the attitude scale scores.

<table>
<thead>
<tr>
<th>Group</th>
<th>Tool</th>
<th>Mean</th>
<th>SD</th>
<th>r</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSC Examination</td>
<td>57.2</td>
<td>18.6</td>
<td></td>
<td>0.667</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Experimental</td>
<td>0.667</td>
<td>&lt;0.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N=31</td>
<td>115.2</td>
<td>15.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude Scale</td>
<td>0.145</td>
<td>&gt;0.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N=30</td>
<td>102.7</td>
<td>15.1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Pearson correlation coefficient was calculated to find the relationship between the achievement scores and the scores in the attitude scale. The relationship is significant ($r = 0.667$ at $p = 0.01$) for the experimental group while insignificant for control group ($r = 0.145$ at $p = 0.01$). It can be seen that the high achievers showed more positive attitude and the low achievers showed least in the experimental group while in the control group the scores are scattered which resulted low correlation between the achievement and attitude scale scores.
It is concluded from the above table that not only have the means risen but the marks are more spread in the experimental group. This implies that some students benefited more, while others may not have benefited at all by the use of Ausubel’s Teaching Strategies. The data presented in the appendix-A showed that the above average students learn more as compared to weak students. The results support the finding of Allen, (1969), who found that advance organizer enhanced learning of above average students as measured by the delayed post-test, but that it had no facilitative effect with below average students.

As the results are significant in favour of Ausubel’s teaching strategies and showed high positive correlation, therefore, it is decided that Ausubel’s teaching strategies helps not only to improve the achievement of the students but also helps to develop the scientific attitude.

**Fifth objective**

To develop the concept maps.

A concept map is a visual representation of an individual’s knowledge structure on a specific topic as constructed by the individual. It represents an individual’s own understanding of specific material.

The more meaningful connections a person can show in the map, the better she/he will understand the material.

The process of preparing a concept map is dependent on what the learner already knows about a particular content, the context, and constructed understanding.

Keeping in view the whole content of all the units presented in the Physics textbook for secondary classes, publish by Punjab Textbook Board Lahore, the researcher followed the following steps to construct the concept map for each unit which are presented in the appendix-D.
Step-by-step Procedure of Concept Mapping

The researcher:

1. Identified the important terms / concepts that he wanted to include on the map.

2. Arranged the concept in a pattern that best represents the information.

3. Enclosed the important terms or concepts with circles/ovals/rectangles. Each circle or rectangle enclosed only one term or concept. However, terms can be more than one word.

4. Connect concepts using straight line with arrows (single or double-headed). Each line linked only two concepts. However, there was not limit to the number of links stemming from any one term. Each concept was defined by its relation to other concepts within the topic. Relations include: superset, subset, attribute, part-whole.

5. Designated the relationship using a word or phrases of words as labels along the line between two connected terms where necessary.
Unit 3

Scalars and Vectors

Physical Quantities

- Scalars
  - Representation of Scalars
    - Specific Unit and Magnitude
- Specific Unit, Magnitude and Direction
- Vectors
  - Representation of Vectors

- Symbolic Representation
- Graphical Representation

Addition of Vectors
- Graphical Method
  - Head to Tail Rule
  - Resultant Vector
- Rectangular Component Method
  - Rectangular Component of Vector

Subtraction of Vector
- Negative of a Vector

Trigonometry
- Trigonometric Ratios
  - Sin θ
  - Cos θ
  - Tan θ
  - Cosec θ
  - Sec θ
  - Cot θ

Resolution of Vectors
- Graphical method
  - Rectangular Component Method
Unit 4 (B)

**KINEMATICS**

- **Length, L**
- **Displacement, d**
- **Distance, s**

- **Velocity (v) = \( \frac{d}{t} \)**
- **Speed = \( \frac{s}{t} \)**

- **Variable velocity/speed**

- **Acceleration (a) = \( \frac{V_f - V_i}{t} \)**
  where \( V_i \) = initial velocity
  \( V_f \) = final velocity
  \( t \) = time

- **Constant acceleration:**
  e.g. Free fall of objects under gravity in the absence of air resistance
  \( a = g = 10 \text{ m s}^{-1} \)

- **Varying acceleration:**
  e.g. Free fall of objects under gravity in the presence of air resistance has decreasing acceleration

- **Area under v - t graph**
  gives distance travelled
  e.g. \( V/\text{m s}^{-1} \)

\[ S = \frac{1}{2} (V_i + V_f) t \]
Unit - 5(A)

FORCES

Vector quantity → Force, F → N (SI Unit)

which can

Change the state of motion or rest (motion and rest are relative terms not absolute)

Causing an object to move in a straight line with increasing speed

Causing an object to slow down for the case of frictional force

Causing an object to move in a circle at constant speed

These can be explained by

Newton's Second Law of Motion

Mathematically it is

\[ F_{\text{net}} = ma \]

where

- \( F_{\text{net}} \) = net force (in N)
- \( m \) = mass (in kg)
- \( a \) = acceleration (in \( \text{ms}^2 \))
Unit 5(B)  Dynamics

Motion

is described by

Newton’s Laws of Motion

1st  2nd  3rd

Applied Force
Vs
Frictional Force

Limiting Friction

Kinetic Friction

Static Friction

Sliding Friction

Rolling Friction

Friction in our Daily Life

Advantages

walking
swimming
knotting
etc.

Disadvantages

noise
depreciation

Methods of Reducing Friction

oiling
greasing
use of ball bearing
shaping
etc.
Unit-6(B)

Turning Effect of a Force

Is a vector quantity

Moment of force (Torque)

Mathematically it is

\[ \text{Torque} = F \times d \]

Which is of two types

F = force
d = perpendicular distance from the force to the pivot

Clockwise moment (usually taken as negative)

Anticlockwise moment (usually taken as positive)

Which if equal called

Principle of moment

related to

Ball e.g. Inside the body may be Centre of gravity Stability can be increased by
* Lowering centre of gravity * Broading the base

Cup e.g. Outside the body Centre of gravity of irregular shaped objects (an experiment)

Centre of gravity of regularly shaped bodies helpful in Solving the problems of equilibrium
Unit-6(C)

EQUILIBRIUM

is

The state of a body in which it is at rest or in the uniform motion (Zero acceleration)

Book on the table e.g. Static equilibrium

First condition of equilibrium

\[ \Sigma F_x = 0 \]
\[ \Sigma F_y = 0 \]

Net force on the body must be zero

Dynamic equilibrium e.g. Motion of a paratrooper

Condition of equilibrium

For an object in equilibrium both conditions must be satisfied

\[ \Sigma \tau = 0 \]

The net rotational effect must be zero

2nd condition of equilibrium

Three states of equilibrium Leads to Suspended / balanced objects regarding their centre of gravity

Stable e.g.

- A book on the table
- For suspended object C.G. Is lower then the point of suspension

Unstable e.g.

- A pencil in the vertical position
- C.G. Is higher than the point of suspension

Neutral e.g.

- A ball on the ground
- C. G. Lies at the point of suspension

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Unit-7(A)  

Circular Motion and Gravitation

Changing of position is Motion

Kinds

Translational  
- Moving Car on the road,  
- free fall of a body.

Vibratory or oscillatory  
- Motion of Swing, pendulum

Circular or Rotational  
- electron around the nucleus  
- movement of earth around its own axis  
- planets around the sun.  
- moon around the earth.  
- moving wheel of cycle.  
- blades of moving fan  
- motorcyclist in the death well.

Random Motion  
- Motion of Smoke butterfly

- a body in circular motion always have variable velocity
- vector is perpendicular to acceleration

Centripetal acceleration  
$\alpha_c = \frac{v^2}{r}$

- Centripetal force

Centrifugal force

★ Banking of Road  
★ Cyclist/Motorcyclist bend towards the circular path  
★ Centrifuge  
★ Washing/spin dryer machine  
★ Separation of cream from milk.
Circular Motion and Gravitation

Gravitation is the force of attraction between two bodies. Newton observed and derived a law called Newton's Law of Gravitation, which is used to measure:

- The mass of Earth
- The velocity of Artificial Satellite

The SI Unit of Gravitation is Newton (N)

Weight:
- $F = w$
- $a = g$
- $w = mg$

A body possesses acceleration due to weight:
- $g = 9.8 \text{m/s}^2$

It depends on The altitude.
Unit-9

Machine

- a device which help human being in doing work efficiently and effectively

Objectives
- shifting of force from one place to another (force of the leg transfer into the wheel of bicycle)
- chang the pace of work (the gear of car)
- chang the direction of force (with the help of handle /stearing)
- lifting heavy load by using a little force (by using screw jack)

Related terms
- effort
- load
- Mechanical Advantage
- input
- output
- Efficiency

Ideal machine
- having efficiency 100%
- Input = Output

Simple machine
- having Output < Input

Complex machine
- consists of more than two simple machines
- having efficiency < 100%
- Input < Output

Kinds
- e.g.
  - sewing machine
  - cycle, car etc.

Lever
- 1st kind
- 2nd kind
- 3rd kind

Inclined plane

Wheel and Axle
- M.A = \frac{l}{h}
- M.A = \frac{1}{\sin Q}

Wedge
- M.A = \frac{2A_1}{h}

Screw Jack
- M.A = 1

Pulleys
- fixed
- movable

Principle of lever
- M.A = \text{effort arm} / \text{load arm}
Unit-10(B)

Fluid

Includ

Gases

Nitrogen, Oxygen and many others gases

The atmosphere because of its weight exert pressure

Application

Magdeburg hemisphere experiment

* The Siphon
* The water pump
* The Syringe

* Mercury barometer
* Aneroid Barometer

Can be used to

Forecast weather

Liquids

Both exert

Pressure

\( P = \frac{F}{A} \)

Pressure in liquid (hdg)

D = density of liquid
h = depth in a liquid

* Hydraulic Machine
* Hydraulic Brake System
* Hydraulic Lift
* Hydraulic Press

Transmitted uniformly in all direction (Pascal’s Principle)

Archimedes Principle

* Ships floats in the sea
* Diving Submarine
* Balloons fly in air

Buoyancy and floating of bodies

1. Weight > upthrust
2. Weight < Upthrust
3. Weight = upthrust
HEAT AND TEMPERATURE

Thermometry

Temperature

measuring instrument

Thermometer

Scale of temperature requires:
- a thermometric substance that has a physical property which varies continuously with temperature.
- two fixed points and a scale between them.

Hotness or Coldness of a body or average K.E of the molecules of a body

Types of thermometers

Liquid-in-glass
- (1) laboratory
- (2) clinical
- simple
- cheap
- portable
- direct reading
- fragile
- limited range e.g. -39°C to 357°C for mercury-in-glass thermometer.

Thermocouple
- wide range of -1200°C to 1500°C
- able to measure localized temperatures
- responsive to rapidly changing temperatures
- robust
- indirect reading
- Maximum and Minimum

Centigrade (Celsius) scale
- two fixed points: (i) ice point (0°C) (ii) steam point 100°C
- defining equation: between them.
\[ ^\circ C = \frac{X - X^*}{X^* - X^*} \times 100 \]

kelvin (absolute) scale
- one fixed point: the triple point of water
- the kelvin (K) is the SI unit for temperature
- relation with celsius scale:
\[ ^\circ C = K - 273 \]
\[ K = ^\circ C + 273 \]

Fahrenheit scale
- two fixed points: (i) ice point (32°F) (ii) steam point 212°F
- relation with celsius scale:
\[ ^\circ C = \frac{5}{9} (^\circ F - 32) \]
\[ ^\circ F = \frac{9}{5} ^\circ C + 32 \]
HEAT AND TEMPERATURE

Joule (SI unit)

Heat

Energy

In transit from a hot to a cold body. Total K.E. of the molecules of body.

expansion

expansion in solid

expansion in liquid

expansion in gases

Real and apparent expansion

gas lawa

Linear expansion

Volumetric thermal expansion

Bimetallic strips

application

- Bimetallic thermometer
- Thermostat
- Fire alarm

Anomalous expansion of water

Effects of Anomalous expansion of water

Boyle’s law

Charle’s law

Pressure law

Gas equation $\frac{PV}{T} =$ constant

- gaps between railway lines
- curved pipe lines are used in deserts etc.
**Unit-11(C)**

**HEATCAPACITY**

- Internal energy of matter → Changes the
- Heat absorbed or released, Q → Law of heat exchange
  - Evaporation
  - Evaporation depends on
    - Nature of liquid
    - Temperature
    - Pressure
    - Surface area
    - Dryness and motion of air
  - Measurement of specific heat
  - Cooling by evaporation
  - Refrigerator

\[ \Delta Q = mc \Delta t \]
Where \( \Delta t \) = temperature change
\( c \) = specific heat capacity
\( m \) = mass

- Specific heat capacity, \( c \) is the amount of heat required to raise the temperature of 1 kg of substance by 1 K (or 1°C)
- Heat capacity, \( c \) is the amount of heat required to raise the temperature of substance by 1 k (or 1°C)

**Transfer of Thermal Energy**

1. Conduction
   - The heat transmits from one part to another part by molecular vibration or free electron diffusion in solid. E.g. Heating of rod at one end.
2. Convection
   - The heat carried from one place to another place by the movement of the liquid/gas itself, e.g. Ventilation in rooms.
3. Radiation
   - The heat transmits from one place to another place without material medium e.g. The sun rays reaching earth.

**Everyday applications:**

1. Boiling water in utensils
2. Davy safety lamp
3. Cavity wall insulation
4. Domestic hot water supply system
5. Refrigerators
6. Vacuum flasks etc.

**Everyday consequences:**

1. Formation of sea breeze and land breeze
2. Greenhouse effect
WAVE MOTION

The disturbance in the medium is Wave Motion

Wave

Visible e.g.
- Motion of rope
- Circular shaped ripples on the surface of water

Invisible e.g.
- Sound
- Radio
- Television

Transverse e.g.
- Waves in a spring
- Sound waves
- Waves produced by engine and bogies

Longitudinal e.g.
- Waves on the surface of water
- Radio waves
- Light waves
- Micro waves

Characteristics

Time period
- SI unit: Sec

Amplitude (X)
- SI unit: m

Velocity (V)
- SI unit: m/s

Frequency (f)
- SI unit: Hz

Wave length (λ)
- SI unit: m

Relationship

v = f

Wave Motion

Periodic motion

The mechanism by which energy and momentum transfer from one place to another without the displacement of matter

A child on a swing
A piston in a cylinder
A bouncing ball
The vibrating strings of violin

Simple harmonic motion

Waves as energy carrier

Simple pendulum
Mass attached to a spring

Behaviour of waves

Reflection

Refraction

Interference

Diffraction

Constructive

Destructive

Two waves of same amplitude and frequency traveling in opposite direction meet one another

Stationary waves
**Unit-12(B)**

**SOUND**

- Transfer from one place to another without the displacement
  - Speed of sound (experiment)
    - 20 Hz to 20,000 Hz
      - Audible frequency of human ear
    - Infrasound f<20Hz
    - Ultrasound f>20,000Hz

- A form of energy
  - Disturbance in the medium
    - Can be felt through
  - A vibrating body
    - Produced by
      - Human vocal cords
      - Diaphragm of Hi-Fi speaker
      - Vibration of tuning fork
      - Beating of drum/bell

- Characteristics
  - Can pass through solid, liquid, gas.
  - Can not travel through vacuum (require certain medium to propagate)

- Behaviour
  - Interference
    - Echo
    - Reflection
  - Resonance
    - Application
      - Stethoscope

- Musical
  - E.g.
    - Voice of cuckoo
    - Sound of violin flute, sitar
  - Characteristics
    - 1. Area of vibrating body
    - 2. Amplitude of vibrating body
    - 3. Distance from vibrating body
    - 4. Direction of wind
    - 5. Nature of the medium
  - Loudness
    - 1. Depends on
    - 2. Pitch
    - 3. Quality
    - 4. Intensity (kN Μ unit)

- Noises
  - E.g.
    - Drawing of crow
    - Sounds of machines, vehicles, donkey etc.

- Application
  - Used in echo-depth sounding device to measure the depth of sea.
  - To kill bacteria and micro-organism in liquid.
  - Cleaning of teeth.
  - Used for diagnostic purposes.
  - Sonar (sound navigation and ranging) used to locate an object by its echo
  - To break the stone in the kidney.

- Watt, m'or bel: in honour of Scientist Alexander Graham Bell
Unit-13

REFLECTION OF LIGHT AND MIRRORS

- Newton’s Corpuscular Theory
- Wave Theory
- Quantum Theory and Dual Nature of light

Light

Propagation
- Rectilinear Propagation of light

Reflection
- Two Laws of Reflection
  - Opaque object
  - Pinhole Camera

Refraction
- Regular reflection
- Irregular reflection

Dispersion
- Spreading of white light into seven constituent colours by a prism (VIBGYOR)

Emission
- Emission of light by atoms

Bohr’s atomic model

Application of the laws of reflection in plane mirrors

- Characteristics of an image formed by plane mirror
  - Same size as of object
  - Virtual
  - Laterally inverted
  - As far behind the mirror as the object is in front

Image formation by converging or diverging light according to the need

Primary

Secondary

The Spectrum

- Center of curvature
- Radius of curvature
- Pole
- Principal Axis
- Focal point/ principal focus
- Focal length
- Obey

\[ \frac{1}{f} = \frac{1}{p} + \frac{1}{q} \]

Rainbows

Kinds

Plane mirror

Spherical mirror

Convex mirror

Concave mirror
REFRACTION OF LIGHT AND OPTICAL INSTRUMENTS

- Refraction of Light and optical Instruments
  - Optical Instruments
    - Refraction of Light
      - Two Laws of Refraction
        - Refractive index
          - \( n = \frac{\sin i}{\sin r} \) (Snell’s-law)
          - \( n = \frac{\text{real depth}}{\text{Apparent depth}} \)
          - \( n = \frac{\text{Speed of light in air}}{\text{Speed of light in material}} \)
        - Critical angle: Is the angle of incidence in the denser medium for which angle of refraction in rare medium is 90°
      - Total internal reflection
        - Occurs under
      - Two Conditions
        - Examples
          - 1. Totally reflecting prism
          - 2. Optical Fibers
          - 3. Periscope and binoculars
    - Diopter
      - Unit
      - Power
      - Lenses
        - Converging
        - Diverging
      - Convex
        - Double Convex
        - Plano Convex
        - Concave
      - Concave
        - Double Concave
        - Plano Concave
        - Convex
      - Human Eye
      - Defects of Vision
        - Short Sightedness
        - Long Sightedness
        - Astigmatism
        - Presbyopia
**Unit-14(B)**

**LENSES**

- **Converging Lens**
  - Main Features
    - Optical Centre
    - Principal Axis
    - Principal Focus (Focal Point)
    - Focal Length
    - Focal Plane
    - Aperture
  - Distance of Object from lens
  - Farther than 2f
    - Real, diminished and inverted
    - Form Images Used in Camera
  - 2f
    - Real and inverted image, and has the same size as object
    - Used in Photocopy Lens
  - Between 2f and f
    - Real magnified and inverted image
  - Less than f
    - Virtual, magnified and upright image
    - Over head projectors/slide projectors
  - Form Image
  - Always small, virtual and upright

- **Lenses**
  - Linear magnification
    - \( M = \frac{q}{p} = \frac{hi}{ho} \)
  - Angular magnification
    - \( M = \frac{\theta_i}{\theta_o} \)
  - Obey
    - \( \frac{1}{f} = \frac{1}{p} + \frac{1}{q} \)
Unit-15

STATIC ELECTRICITY

Electrostatics

- is a study of

Positive and negative charges Q

- Which set up in the space around them

Static Charges

- Produced on the surfaces of

Separation of Charges

- Electrostatic Induction

- Electrostatic Potential

Electric fields

- Represented by

Lines of Force

Electric conductors

- by the process of

Induction

Electric insulators

- by the process of

Friction

Can be detected

- Electroscope

Can be stored in

- Can be used in

1. Lightning
2. Fires etc.

1. High-voltage generator
2. Spray Painting

Parallel Plate Capacitor

Simple Structure

Capacitor

- Capacity of capacitor

Kinds

- Fixed
- Variable

- e.g. Paper capacitor
- Mica capacitor

Electric Fans, motors etc.

Transistor radio for tunning

Farad (F)

SI Unit
**CURRENT ELECTRICITY**

Current Electricity is a study of moving charges that produces an electric current, I. Electric current, I, is defined as the flow of electric charge per unit time.

\[ I = \frac{Q}{t} \]

where

- \( I \) = current (SI unit: A)
- \( Q \) = charge
- \( t \) = time (SI unit: s)

Electric current is established by a potential difference, V, and produced by a source of electromotive force (e.m.f.).

\[ V \]

Potential difference, V, is measured in SI units of Joules per Coulomb (J/C).

Resistance, R, of the material depends inversely on potential difference, V, and is given by:

\[ R = \frac{V}{I} \]

where

- \( R \) = resistance (SI unit: Ω)
- \( V \) = potential difference
- \( I \) = electric current

Resistance is calculated using the formula:

\[ R = \frac{P}{A} \]

where

- \( P \) = resistivity
- \( A \) = cross-sectional area
- \( I \) = length

If constant:

- Ohmic conductors such as pure metal
  - Ohm’s law: \( I \propto V \)
  - Kinds of circuits
  - Series circuits: Common I
    \[ R = R_1 + R_2 + \ldots + R_n \]
  - Parallel circuits: Common I
    \[ \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_n} \]

If not constant:

- Non-Ohmic conductors such as semiconductors, thermistors etc.

Unit-16(B)

Practical Electric Circuitry

Deals with the use of electricity in:

- Electric lighting
- Electric heating
- Electric motors

Which consumes power and energy given by

- Fuse to protect equipment/wiring from excessive current.
- Switches fitted on the live wire to disconnect the high voltage from an appliance.
- Earthing to protect user in the event of the metal casing of an appliance becoming live.
- Double insulation to substitute for an earth wire.
- Circuit breaker

Can cause electric shocks or fires in situations such as

- Damaged insulation
- Overheating of cables
- Damp conditions

Which can be prevented by using

Safety measures

Such as

Kilowatt-hours (kWh)
(the domestic units of electricity)

P = IV
Where
P = Power (W)
I = Current (A)
V = Potential difference (V)

E = Pt
Where
E = Energy (J)
P = Power (W)
t = Time (S)

Used in finding the cost of electricity consumption in
Magnetism

Comprises

Magnets

Electromagnets (temporary magnets) made from iron

Magnetic materials e.g. e.g. e.g. e.g.

Cobalt

Steel

Nickel

Permanent magnets made from

Can produce Induced magnetism

Exhibit the properties

- North and South Poles
- Law of magnetic poles
- Attract magnetic materials

Magnetic force Exerted

Which acts by means of setting up a

Can be made by

Stroking
- Electrical means

Permanent magnets Demagnetised

Electromagnets

Heating
- Hammering
- Passing an alternating current

Plotting by Compass

Moving-coil galvanometer
- Moving-coil loudspeaker
- Magnetic door catch
- Electrical machines etc.

Have the following uses

- Electric bell
- Magnetic relay
- Reed switch
- Circuit breaker etc.

- Moving-coil galvanometer
- Moving-coil loudspeaker
- Magnetic door catch
- Electrical machines etc.
ELECTROMAGNETISM

Electromagnetism

Involves the study of

Magnetic forces produced by electric currents

Passing through

Electromagnet

Used in

- Electric bell, motor fan, telephone receiver
- To produce high magnetic field
- To remove iron piece from eye

Forces on moving charges in a magnetic field

Result in

Circular lines of force

Right hand rules

Straight wire immersed in an external magnetic field

Direction can be found by

Fleming’s Left hand Rule

Used in the

Loudspeaker

Two parallel current carrying wires

Which

- Attract for like currents
- Repel for unlike currents

Rectangular coil immersed in an external magnetic field

Whose turning effect is applied in the

D.C motor
ELECTROMAGNETIC EFFECTS

Electromagnetic Effects

Can be described by

- Faraday’s Law
  The e.m.f. produced in a conductor is proportional to the rate of change of the magnetic lines of force (flux) linking the circuit.

- Lenz’s Law
  The direction of the induced e.m.f. and induced current in a closed circuit is always such as to oppose the change producing it.

Used in

- A.C. Generator
  An electromagnetic device that transforms mechanical energy into electrical energy which is in the form of an alternating output voltage.

- Transformer
  A device that changes a high alternating voltage at low current to a low alternating voltage at high current or vice-versa.
  - $V_o = N_o$
  - $V_i = N_i$
  - $I_o V_o = I_i V_i$
Electronics

Is the Study of

Properties of Electrons
Which are

Emitted by Thermionic Emission
Are

* Electric Field
* Magnetic Field
Used in

Cathode Ray Oscilloscope Tube
Is used in

Cathode Ray Oscilloscope
Televisions

* Measuring Voltages
* Displaying Voltage in Waveforms
* Measuring short Intervals of time by using time-base

Development of Electron emitting devices

Electric Components

* Resistor
  It controls the current flowing through the circuit
* Light-Dependent Resistor
* Resistance decreases with increasing amount of light incident on it.
* Potentiometer
  regulates the potential difference across a device.

Electrical Circuits

Digital Circuits

Digital Quantities

Digital to Analogue or Analogue to Digital Converter

Analogue Circuits

Analogue Quantities

Whose

Input and output involve only two voltage levels High (1) or Low (0)
Include

Basic Operations and gates of digital Electronics

* And Operation
* Or Operation
* Not Operation
* Nand Operation
* Nor Operation

Used in

* Safty Alarm
* In houses, vehicles
Unit-18(B)  

**Electrical conductivity**

Material things According to electrical conductivity

- Conductors
  - Very low resistance of the order of $10^0$ ohms
  - A lot of free electrons are available
  - Metals, Iron, copper, gold etc.

- Semi-conductors
  - Moderate resistance of the order of $10^0$ ohms
  - Insulator at low temperature
  - Silicon & Germanium
    - Conducting can be increased by addition of 3rd group element
    - P-type semi-conductor
    - N-type semi-conductor
      - Together make up

- Insulators or Non-Conductors
  - Very high resistance of the order of $10^0$ ohms
  - Very less free electrons are available
  - Wood, plastic glass, mica etc.

**Transistor or semi-conductor triode**

- Amplifier
- T.V., Radio etc
  - NPN
  - Three parts: emitter, base, collector
  - Consists of Emulator-Base Junction (Forward biased)
  - Collector-Base Junction (Reverse biased)

**P-N Junction semi-conductor diode**

- Have two kinds
  - Forward biased
  - Reverse biased
  - Used as Rectifier
    - Full wave rectifier
    - Half wave Rectifier
Unit-19

Information Technology

Storage of Information Logical Arrangement

Communication

Face to Face

Tele Communication

Data Management
MIS
EDU
Business
Medical
CAD

Computer

Input Devices
Include
Key Board

Output Devices
Include
Monitor

Input Devices
Include
Key Board

Printed Devices

Books
Encyclopedia
New Papers

Devices Electronic e.g
CD
H.D
Floppy Disk
Laser Disk
DVD
ATM

Mobile Phone
Telex Machine
Audio Player
Audio Tapes
Radio
T.V
Video Player
Video Tapes

Store Information
CHAPTER 5

SUMMARY, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

The aim of this chapter is to bring together the findings from this study and summaries the outcomes. This involves looking at the strengths and weaknesses of the study and the significance for future work as well as the recommendations for further studies.

5.1. Summary

In Pakistan, the traditional way of teaching in the science subjects at all levels at school relies heavily on the presentation of material in a lecture format, the students being required to record and then memories what is taught. This assumes that the educational process is built around the transfer of knowledge from the head of the teacher (with help from textbooks etc) to the heads of the young learners. It ignores the innate ability of learners to construct their own understandings. It leads to memories knowledge where ideas are not linked together, where most of what is learned is quickly forgotten simply because there are few links between ideas to enable the learner to recall after a period of time. It means that learners rarely can apply their knowledge in what is learned, is not really understood. Because the traditional method fails to work within the natural tendency of learners to seek to understand, then attitudes towards what is to be learned, the learning process and to education in general may well deteriorated, with long term consequences for future learning. The only advantage is that it allows the easy setting of examinations and tests, these simply measuring the efficiency of recall for recognition. The whole process is a highly inconsistent way to educate. Indeed it can hardly be called education. There is, therefore, the huge need to re-think the whole process of teaching and learning in order to improve education. This study seeks to contribute to this
development by considering how the insights of Ausubel can be converted into effective and efficient instructional method, looking specifically at physics.”

The traditional teaching method (lecturing/ book learning by rote / memorization of facts, theories, principles etc.) are widely being used in teaching of science subjects at secondary level in Pakistan, despite of knowing their merits and demerits. The researchers, educationists and the curriculum planners are seriously thinking about how to improve the quality of science education through the effective use of these instructional methods. Therefore this study was taken up to compare the relative effectiveness of Ausubelian teaching method and traditional teaching method in the teaching of physics at secondary level in Pakistan. The study proved that the results shown by Ausubel’s teaching methods in physics (theory and practical) are better in achievement and performance in the lab than the controlled group and it has made it easy to pave the way for research in order to lead the teachers to adopt Ausubel’s teaching strategy, in the teaching of physics.

The study was delimited because of the limited resources, to 62 male science students of 10th class in the subject of physics of Govt. Comprehensive School, Jhelum (Pakistan). In this study the following achievement tests were used as measuring instrument. These tests were administered to the sample according to the schedule mentioned in chapter -1.

1. Experimenter’s tool I and II (physics theory and practical).

2. Term Tests I and II (physics theory and practical) administered by the controller of examination of the school to the whole sample.

3. An achievement test of physics (SSC examination 2005) developed, administered and evaluated by the Board of Intermediate and Secondary Education Rawalpindi (Pakistan).
The 10th class science students of Government Comprehensive High School, Jhelum (Pakistan) were divided into two equivalent groups on the basis of an achievement test from 8th class science. One group was randomly selected and named as experimental (treatment) group and other was given the name of controlled group. The experimental group was instructed through Ausubel’s Teaching method while the controlled group was taught through Traditional. Both the groups were taught for the period of 35 weeks at the rate of two periods of 35 minutes per day and 5 days per week.

In the physics laboratory, the students came once per week (every Saturday) for one and half an hour. The control group came on each Saturday from 8:30 am to 10:00 am, and the experimental group came from 10:00 am to 11:30 am in the physics laboratory for practical work. For each practical, along with pre-lab sheet, a lecture of thirty minutes was delivered to the experimental group at least three days before the actual laboratory work. The pre-lab lecture was delivered in the zero-period. Each student with pre-lab was expected to do some preparatory work in the form of pre-lab before he came to the lab.

To find the effectiveness of pre-labs, post labs were administered to the whole sample after the end of actual practical work on every Saturday. The post – labs consisted of written work, objective type test items and some practical work. The timetable was prepared and adjusted with the regular timetable of the school. The posttest only equivalent group design was used for this study.

At the end of the academic session the attitude scale was administered to the whole sample to measure the scientific attitude of the sample (students). To test the hypotheses of the study, t-test was applied to find the significant difference between the two mean scores of the experimental and control group.

The overall picture that emerged from the analysis of date was in favour of Ausubel’s teaching method. So almost all the null hypotheses were rejected which proved
that Ausubel’s teaching method (ATM) is better than Traditional teaching method (TTM) in the teaching of physics at secondary level.

Every human effort has flawed, so is the case with this research study. There are some weaknesses which are addressed below:

a) The key weakness of the study lies in the use of two teachers. The fact that the two teachers have similar experiences and qualification is not enough. Their personalities and their views of teaching may be different. To avoid this weakness, the teacher was informed about the purpose of this study. Training was given to the teacher along with written material about traditional teaching strategy, (i.e. how to plan and present the material in the class) so that the biases should be minimized. There may be a strong interaction between the new method and the researcher but which the other teacher may not experience. This does not, of itself, make the study incorrect but this was the issue that must be solved in future by taking four randomize matched groups, two taught by the researcher that is one by Ausubel’s teaching method and one by traditional, and two groups should be taught by the other teacher that is one by Ausubel’s teaching method and one by traditional. The net result will show is there any difference between the two teaching strategies.

b) The small sample of boys-only is a limitation but not too important because the sheer scale of the work (over much of thirty-five weeks) strengthens the case. The sample size may be increased by adding the female sample in future.

c) Any group of learners, if they are exposed to something new, will react positively, simply because it is new and they are getting special treatment. The approach is very different from that of their past experience and even if they were never told that the approach was new, they would know it was something exciting because it is different and they will talk to the members of the control group. To avoid this weakness, the experiment should be conducted at different schools/regions/places where the interaction between the groups may not be possible.
d) Further assessment issues are very interesting. Researcher used “experimenter’s tools” and “post-labs”, which were based on measurement of understanding, application, and sustained argument and so on. This almost certainly explains the variable results. The school tests and national examinations almost certainly merely measured recall.

5.2 Findings

The results have been drawn keeping in view the objectives formulated for this study and by the testing of the hypotheses framed thereafter. Major findings of the study drawn out of the foregoing chapters, presented in accordance with the objectives, are as follows:

1. A significant difference was found between the achievement scores of students in the subject of physics theory taught through Ausubelian and Traditional teaching methods as measured by experimenter’s tools I. (H$_{01}$ rejected)

2. A significant difference was found the achievement scores of the students in the subject of Physics (Practical) taught through Ausubelian and Traditional teaching methods as measured by experimenter’s tool ‘1’. (H$_{02}$ rejected)

3. A significant difference was found between the achievement scores of the students in the subject of Physics (Theory + Practical) taught through Ausubelian and Traditional teaching methods as measured by experimenter’s tool ‘1’. (H$_{03}$ rejected)

4. A significant difference was found between the achievement scores of students in the subject of Physics (Theory) taught through Ausubelian and Traditional teaching methods as measured by experimenter’s tools ‘2’. (H$_{04}$ rejected)

5. A significant difference was found between the achievement scores of the students in the subject of Physics (Practical) taught through Ausubelian and
Traditional teaching methods as measured by experimenter’s tool ‘2’. (H05. rejected)

6. A significant difference was found between the achievement scores of the students in the subject of Physics (Theory + Practical) taught through Ausubelian and Traditional teaching methods as measured by experimenter’s tool ‘2’. (H06. rejected)

7. A significant difference was found between the total achievement scores of the students in the subject of Physics (Theory) taught through Ausubelian and Traditional teaching methods as measured by experimenter’s tool ‘1 and 2’. (H07. rejected)

8. A significant difference was found between the total achievement scores of the students in the subject of Physics (Practical) taught through Ausubelian and Traditional teaching methods as measured by experimenter’s tool ‘1 and 2’. (H08. rejected)

9. A significant difference was found between the total achievement scores of the students in the subject of Physics (Theory + Practical) taught through Ausubelian and Traditional teaching methods as measured by experimenter’s tool ‘1 and 2’. (H09. rejected)

10. A significant difference was found between the achievement scores of students in the subject of Physics (Theory) taught through Ausubelian and Traditional teaching methods as measured by ‘First Term Test’. (H10. rejected)

11. A significant difference was found between the achievement scores of students in the subject of Physics (Practical) taught through Ausubelian and Traditional teaching methods as measured by ‘First Term Test’. (H11. rejected)
12. A significant difference was found between the achievement scores of students in the subject of Physics (Theory + Practical) taught through Ausubelian and Traditional teaching methods as measured by ‘First Term Test’. ($H_{012}$ rejected)

13. A significant difference was found between the achievement scores of students in the subject of Physics (Theory) taught through Ausubelian and Traditional teaching methods as measured by ‘Second Term Test’. ($H_{013}$ rejected)

14. A significant difference was found between the achievement scores of students in the subject of Physics (Practical) taught through Ausubelian and Traditional teaching methods as measured by ‘Second Term Test’. ($H_{014}$ rejected)

15. A significant difference was found between the achievement scores of students in the subject of Physics (Theory + Practical) taught through Ausubelian and Traditional teaching methods as measured by ‘Second Term Test’. ($H_{015}$ rejected)

16. A significant difference was found between the total achievement scores of the students in the subject of Physics (Theory) taught through Ausubelian and Traditional teaching methods as measured by First and Second Term Test. ($H_{016}$ rejected)

17. A significant difference was found between the total achievement scores of the students in the subject of Physics (Practical) taught through Ausubelian and Traditional teaching methods as measured by First and Second Term Test. ($H_{017}$ rejected)

18. A significant difference was found between the total achievement scores of the students in the subject of Physics (Theory + Practical) taught through Ausubelian and Traditional teaching methods as measured by First and Second Term Test. ($H_{018}$ rejected)
19. A significant difference was found between the achievement scores of the students in the subject of physics (theory and practical) taught by the use of Ausubelian and Traditional teaching methods in the secondary school certificate (SSC) examination conducted by the Board of Intermediate and Secondary Education Rawalpindi, Annual 2005. (H_{O19}. rejected)

20. A significant difference was found between the achievement scores of the students in the subject of physics theory as measured by the use of Ausubelian and Traditional teaching methods in the SSC examination conducted by the BISE Rawalpindi, Annual 2005. (H_{O20}. rejected)

21. A significant difference was found between the achievement scores of the students in the subject of physics practical as measured by the use of Ausubelian and Traditional teaching methods in the SSC examination conducted by the BISE Rawalpindi, Annual 2005. (H_{O21}. rejected)

22. A significant difference was found between the achievement of the students with pre-lab and students without pre-lab in the post labs results. (H_{O22}. rejected)

23. A significant gain was observed in the scientific attitude of the students in favour of the experimental group. (H_{O23}. rejected)

24. High positive correlation was found between the marks achieved by the students in the SSC examination 2005 and their attitude scale scores. (H_{O24}. rejected)

5.3 Conclusions


2. The pre-labs significantly help the students to improve their performance in the physics laboratory. (Zaman, 1996, Shian and Janice, 2004)

4. Since post-labs were testing the understanding of principles encountered in the laboratory and also testing their use in unfamiliar situations, improvement in post-lab performance is a good indication of learning gain from the laboratory experience. (Zaman, 1996, Shian and Janice, 2004)

5. Post-labs, although used for measurement purposes, almost certainly have an important function in consolidating what was learned in the lab, and helping the students to link new knowledge to existing knowledge. (Zaman, 1996, Johnstone and Zaman, 1998, Shian and Janice, 2004, Limnious, 2008)

6. It would seem to be reasonable to link an improvement in attitude with an improvement in learning. The learning recorded certainly has an attitudinal as well as cognitive component. (Ma & Kishor, 1997).

7. Ausubelian teaching method helps to inculcate scientific attitude among the students. (Morgan, 1985, Zaman, 1996)

8. The use of pre-lab activities has significantly increased the frequency of positive attitude among the students towards the laboratory work. (Zaman, 1996)

9. The large increase in standard deviation for the experimental group implies that some students have benefited greatly, while other less.
5.4 Recommendations

1. In Pakistan, the teaching strategies in science with development of mental processes, particularly their integration in the science classroom and physical science laboratories, have remained almost completely unexposed. No study has been attempted in this direction, many linked questions and issues remain unanswered. Hence a lot of research studies need to be attempted to solve these issues and problems.

2. This study can be seen as an exploratory study and offers encouragement that the new approach as considerable value for the learners. It needs replicated, using many teachers, with boys and girls, and in all three science disciplines.

3. There is a need to re-think the aims of laboratory work in all three science disciplines to move it away from the repetition of verification type experiments towards a more open-ended enquiry which allows the students to see science in action as it seeks to understand the world around.

4. The role and value of pre-lab and post-lab experiences is well documented in the literature but mostly at university level. This study is consistent with past findings but at school level and is also specifically consistent with the findings of Shah (2004). It is recommended that this approach be adopted widely in Pakistan.

5. The persistent increase in the standard deviations obtained for the experimental group suggests that not all students are benefiting equally. There is a need to explore this further by looking at the learner characteristics of that group which benefited least by the new approach. Actually, it would be worth looking at individual students to see whether there are any discernable patterns among those in the experimental group who did exceptionally badly.
6. If other school subjects continue to be taught in a memorization-recall system is it possible for students to change their approach only in the sciences? This needs major exploration.

7. The whole assessment system in Pakistan needs major overhaul.

8. In addition to the achievement and attitude of the students, other variables of instruction should be tested.

9. Variables like pupils’ cognitive level, variability of schools, students’ background, students’ conceptual level, creative potential and the like can be studied in relation to different strategy of teaching.

10. The nature of pre-lab and post-lab need more improvement and further investigation at other levels and regions.

11. Pre-labs are known to exist elsewhere ranging from written assignments to computer assisted learning, similarly, the post-labs are of different kinds (viva voce, written reports, post-lab discussions etc.). All of these have different experiences. Their relative effectiveness should be evaluated so that the more effective tools can be used in the future.

12. The results indicate that ATS in the teaching of physics enhanced the conceptual understanding of the secondary school science students. Hence the textbooks of science, especially physics, and the physics practical manual should be modified according to the ATS and the concept maps.

13. The style and nature of assessment will define the objectives to be achieved. Pupils are not dull. They will learn in such a way to maximize their chance of success. If recall is rewarded, they will recall. Teachers are also not unintelligent. They will teach in such a way to maximize their student’s chances of success. If
recall is rewarded, they will emphasise recall. The problem almost never lies with teachers. It lies with the assessment systems and the national systems will determine everything because they set the agendas for success. You could train every teacher in Pakistan to teach in a better way but nothing would happen until the examination system changes. Hence it is recommended that the national assessment paradigm should be shifted from recall to understanding.


http://dbweb.liv.ac.uk/tsnpsc/quides/PedagogResearch/GettingStarted

http://ndundam.people.cofc.edu/EDFSSPRG2003/EDFS635/Chap5.doc


Huttenlocker, J. (1962). Some effects of negative instances on the formation of simple concepts. Psychology Reports. 11: 35. p.59


Appendix- A

Group Formation (Experimental & Control)

*Marks achieved by the students in the Subject of 8th Class Science (Max:50)*

<table>
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<tr>
<th>Sr. No.</th>
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<th>Marks Obt.</th>
<th>Sr. No.</th>
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## Experimental Group

*Marks achieved by the students in the subject of Physics (Part I & Part II)*

*Theory & Practical, During the Session 2004-2005*

*(Results of Experimenter’s Tool)*

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## Control Group

*Marks achieved by the students in the subject of Physics (Part I, Part II)*

*Theory & Practical, During the Session 2004-2005*

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Theory & Practical in the S.S.C. Annual Examination 2005

Total Marks: 100  Theory: 75  Practical: 25

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Mean Score 36.5  20.7  57.2
Control Group

*Marks achieved by the students in the subject of Physics
Theory & Practical in the S.S.C. Annual Examination 2005*

**Total Marks: 100**  
**Theory: 75**  
**Practical: 25**

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**Mean Score**  
25.9  
18.5  
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# Attitude Scale Score of Experimental & Control Groups

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# Appendix - B

## Table of Specification of 8th Class Science

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Test of 8th Class Science

TO EQUATE THE EXPERIMENTAL & CONTROL GROUP

Name: ________________________________   Roll No: ___________

Max. Marks: 50                                                                                       Time: 1 Hour

FILL IN THE BLANKS

1. The gigantic clouds of dust and gases in space are called ______________

2. $\text{CaCO}_3 + \text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{______________}$.

3. Rocks formed by the cooling of magma or lava is called ________rocks.

4. Virus is a Latin word, which mean ____________________________.

5. Dry cells use in torch / toys changes __________energy into electrical energy.

6. The image formed by a concave lens is always _________________.

7. The instrument used to measure the temperature of a body is called ________.

8. The flow of charge from one place to another in one second is called_______.

9. The distance between the optical center and principal focus is known as ____.

10. Soap is prepared by heating sodium hydroxide and _________________.

Read the Statement Carefully and Encircle the Correct Answer.

1. Thermal power plant converts
   (a) Mechanical energy into electrical energy.
   (b) Chemical energy into electrical energy.
   (c) Heat energy into electrical energy.
   (d) Nuclear energy into electrical energy.

2. The unit of electric power is:
   (a) Ampere       (b) Volt
   (c) Watt         (d) Kilowatt-hour

3. The formula of ozone is:
   (a) O       (b) O$_2$
   (c) O$_3$    (d) O$_4$

4. Which is the symbol of copper:
   (a) Cu     (b) Co
   (c) Ca     (d) Cl

5. The change in direction and speed of light from one medium to another is Called:
   (a) Reflection of Light   (b) Refraction of Light
   (c) Dispersion of Light   (d) Interference of Light

6. Which is the crystalline form of carbon?
   (a) Coal     (b) Diamond
   (c) Charcoal (d) Coke

7. The steam is a source of:
   (a) Mechanical energy   (b) Nuclear energy
   (c) Potential energy    (d) Chemical energy

8. A lighted bulb consumes:
   (a) Mechanical energy   (b) Nuclear energy
   (c) Potential energy    (d) Electrical energy

9. Which one is similar to aperture of the camera?
   (a) Retina    (b) Eye ball
   (c) Cornea    (d) Iris

10. On Farenheit scale, the melting point of ice is:
    (a) 0   (b) 32
     (c) 100 (d) 273
Answers of the Following Questions on the Space Given Below.

1. Why the ice floats on the surface of water?

2. What is catenation?

3. Write two differences between real and virtual image.

4. What is the reason behind why two sections of railway track are joined by fishplates?

5. Define chemical formula with the help of one example.

6. Write two properties of ionic compounds.

7. Define Light year.
8. How metamorphic rocks are formed?

9. How electricity is generated in a hydral power station?

10. Name the salt which can reduces the acidity in our stomach.
# Table of Specification for Experimenter’s Tool I

## (UNIT 1 to 10)

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Experimenter’s Tool I for class X Physics

Max. Marks 75      Time 2 ½ hour
Name: _____________________________   Roll No: _____________

Note: Read the statements carefully and (✓) the most suitable choice.  (15)

1. Dr. Abdul-s-Salam was awarded Nobel Prize for his work on;
   (a) Quantum theory  (b) Corpuscular theory of light
   (c) Grand unification theory (d) Theory of Relativity

2. What is the magnitude of the resultant force, when two forces of 3N & 4N are perpendicularly acting on a body?
   (a) 7N               (b) 12N
   (c) 1N    (d) 5N

3. A stone of mass 2kg falls from the top of a tower and reaches the ground in 4 seconds. How long will it take a stone of mass 4kg to fall to the ground from the top of the same tower?
   (a) 2 seconds              (b) 4 seconds
   (c) 6seconds   (d) 8 seconds

4. Equal forces applied on tennis and cricket balls of equal volumes, the acceleration in
   (a) Plastic ball is greater than cricket  (b) both balls is equal
   (c) Plastic ball is less than cricket (d) none of a, b, c

5. If the uniform speed of a body moving in a circle is doubled, its centripetal force becomes;
   (a) Twice               (b) Three time
   (c) Four time   (d) Eight time

6. Which one is more elastic?
   (a) Air               (b) Water
   (c) Steel   (d) Rubber
7. A stone is dropped from a tower. It reaches the ground in 10 seconds. What is its velocity when it hits the ground?

(a) 1.00 m/s  
(b) 10.0 m/s  
(c) 100 m/s  
(d) 1000 m/s

8. The output of a machine is always;

(a) Equal to input  
(b) Less than input  
(c) Greater than input  
(d) Some time less some time greater

9. Torque is the product of;

(a) Force and displacement  
(b) Force and force arm  
(c) Force and mass  
(d) force and acceleration

10. A simple pendulum is made of plastic ball (as a bob), filled with water and have a hole in it. During the oscillation, it’s mass continuously decreasing. What will be the effect on the time-period of the pendulum?

(a) It will increase  
(b) It will decrease  
(c) It will remain same  
(d) None of a, b, c.

11. The molecular theory of matter was experimentally tested by:

(a) Hooks  
(b) Archimedes  
(c) Pascal  
(d) Brown

12. The unit of coefficient of friction is:

(a) Pascal  
(b) Joule  
(c) None  
(d) Newton

13. The average speed of human being is:

(a) 2 km/h  
(b) 4 km/h  
(c) 6 km/h  
(d) 8 km/h

14. What will be the work done, if a force of 100N acts on a body, making an angle of 45° with horizontal?

(a) 0.707 N  
(b) 7.07 N  
(c) 100 N  
(d) 70.7 N
15. When water changes into ice, it:

(a) Contracts    (b) Expands
(c) Becomes dense   (d) Volume decreases

**Part B**

**Answer the following questions. (Give scientific reason where necessary)**  (30)

1. Why is a standard unit needed to measure a quantity correctly?
2. A stone of mass 5 kg thrown in the downward direction from a tower and reaches the surface of Earth in 5 seconds. How long a 10 kg stone will take to reach the Earth?
3. Why is the friction of rolling bodies less than that of sliding bodies?
4. Under what condition the sum of three vectors will be zero?
5. Can a moving body be in equilibrium?
6. Which vehicle has more danger of over turning on an inclined road? A Car or Tractor. Give its reason.
7. Why a cyclist bends himself towards the inner side of a curved path while taking turn with high speed?
8. How much power does a 50 kg athlete use by climbing 10 m high stairs in 10s?
9. How heavy stones were shifted from ground to a big height for the construction of Egyptian Pyramids (the first wonder of the world)?
10. A ship is mostly made of iron, but it floats on the sea surface, while a small needle sinks. Why?
11. Define the following terms: effort, load, mechanical advantage, and efficiency.
12. Differentiate between random error and a systematic error in the measurement of any physical quantity.
13. Can you explain why an inflated balloon shoots off when its air is released?
14. What is scientific method? Write its different stages.
15. Diagram shows the reading obtained for the diameter of a wire. If screwguage has no zero-error then calculate the diameter of the wire.
Q 1. (a) Define friction. Also describe advantages and disadvantages of friction.  
(b) In order to push a box of 50 kg mass on the floor, a force of 300 N is required. What will be the coefficient of friction existing between the box and the floor?

Q 2. (a) Define torque. What are the factors on which it depends?  
(b) Calculate the mass of Earth by using Newton’s Law of Gravitation.

Q 3. (a) Define the following: Stress, Strain, Surface Tension, Viscosity, and Pressure.  
(b) Define Pascal’s law and give its two applications in daily life.


Experimenter’s Tool I for Class X Physics

Practical Examination

Max. Marks 25

Name: _____________________________   Roll No: ___________

Note: Perform any one practical. (20)

A Find the volume of given cylinder with the help of vernier callipers & verify the volume by using measuring cylinder.

OR

Find the centre of gravity of a given meter rod. Find the weight of the given stone by using principal of lever.

B. Note book. (2)

C. Viva Voce. (3)
# Table of Specification for Experimenter’s Tool II

(UNIT 11 to 20)

<table>
<thead>
<tr>
<th>Content</th>
<th>Objectives</th>
</tr>
</thead>
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<tr>
<td></td>
<td>Knows</td>
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<tr>
<td>Heat and Temperature</td>
<td></td>
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<td>Wave Motion and Sound</td>
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<tr>
<td>Reflection of light and mirrors</td>
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<td>Refraction of light and optical instruments</td>
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<td>Static &amp; Current Electricity</td>
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<tr>
<td>Magnetism</td>
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<td>Electronics &amp; Electrical Conductivity</td>
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<td>Nuclear Physics</td>
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<td>Total</td>
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Experimenter’s Tool II for Class X Physics

Max. Marks 75 

Name: _____________________________   Roll No: _____________

Note:  Read the statements carefully and (✓) the most suitable choice.

(10)

1. Magnet attracts the things made of;

   (a) Nicle        (b) Iron
   (c) Cobolt       (d) all a, b, c.

2. Magnetic lines of forces can easily pass through;

   (a) Air               (b) Water
   (c) Wood               (d) Iron

3. If a ray of light strikes perpendicularly on the surface of a plane mirror, the angle of reflection will be of;

   (a) 180°        (b) 90°
   (c) 45°         (d) 0°

4. The image formed on the film of a camera (the negative) is;

   (a) virtual, erected and small       (b) virtual, inverted and small
   (c) real, erected and small          (d) virtual, inverted and small

5. The swimming pool looks less deep due to;

   (a) reflection of light       (b) refraction of light
   (c) dispersion of light       (d) diffusion of light

6. The number of protons in the nucleus of an atom is called;

   (a) Avogadro number       (b) atomic number
   (c) nucleons number       (d) mass number

7. To measure current in the circuit an ammeter is always connected;

   (a) in series       (b) in parallel
   (c) in any way    (d) parallel to voltmeter
8. The unit of resistance is:
   (a) Ohm     (b) Ampere
   (c) Volt    (d) Coulomb

9. If frequency of waves is 100 Hz. And wave length is 0.2 meter, then velocity of waves is:
   (a) 2000 m/s    (b) 200 m/s
   (c) 20 m/s      (d) 2.0 m/s

10. The sound waves are:
    (a) Magnetic waves   (b) Longitudinal
        (c) Electromagnetic waves (d) Transverse

B. Match the physical quantity with there unit: (5)

<table>
<thead>
<tr>
<th>Column “A”</th>
<th>Column “B”</th>
<th>Column “C”</th>
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</thead>
<tbody>
<tr>
<td>a. Charge</td>
<td>1. Ohm</td>
<td></td>
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<tr>
<td>b. Current</td>
<td>2. Farad</td>
<td></td>
</tr>
<tr>
<td>c. Capacitance</td>
<td>3. Ampere</td>
<td></td>
</tr>
<tr>
<td>d. Potential difference</td>
<td>4. Joule</td>
<td></td>
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<tr>
<td>e. Resistance</td>
<td>5. Coulomb</td>
<td>6. Watt</td>
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<tr>
<td></td>
<td></td>
<td>7. Volt</td>
</tr>
</tbody>
</table>
C. Answer the following questions. (30)

1. Write what type of waves formed on the surface of water? Give one more example of that type of wave.
2. What is the difference between crest and trough?
3. Write two differences between heat and temperature.
4. How are stationary waves produced?
5. What are the factors on which electromagnetism depends?
6. What is the difference between ‘potential difference’ and ‘electro motive force’?
7. How are X-rays and infrared rays alike? (Write two similarities)
8. What is the reason behind short sightedness?
9. Give a comparison of camera and an eye.
10. What is the cause of natural radioactivity?
11. Highly pure silicon and germanium is insulator at low temperature. Why?
12. How rainbow is produced?
13. A boy drops a stone into a pond and as a result a stick floating on the surface of water 10 meter away, begins to move. Explain how?
14. Write two application of ultrasonic.
15. Write two uses of diode.

D. Write the answer of the following Questions. (30)

Q 1. (a) What is the difference between musical sound and noise? Briefly describe the characteristics of musical sound?
   (b) There are 48 holes in a disc siren arranged in the form of a ring. The disc rotates at 400 revolutions per half minute. What is the frequency of the sound emitted by an air jet placed against the holes?

Q2. (a) Explain the phenomena of mirage keeping in view the concept of total internal reflection.
   (b) The focal length of a convex lens is 10 cm. Where should an object be placed to get (1) a real image (2) a virtual image, twice the size of the object?

Q3. (a) How p-type and n-type semiconductors formed.
   (b) What are radio-isotopes? Write usefulness of radioisotopes in medicine, and agriculture.
Experimenter’s Tool II for Class X Physics

Practical Examination

Max. Marks 25  Time 1 ½ hour

Name: _____________________________   Roll No: ____________

Note: Perform any one practical. (20)

A. Study the effect of length of a simple pendulum on the time period and mass, and calculate the value of ‘g’ by using mean length and mean time period.

OR

Determine the focal length of a convex lens by two pin method. (Parallax method)

B. Note book. (2)

C. Viva Voce. (3)
Government Comprehensive High School Jhelum

(First Term Test Physics (Theory) Class X)

Name _____________________________________ Roll No. _____________

Max Marks: 75 Time: 2:30Hrs.

Part I

Q1. Fill in the blanks.

(i) Leaser is the field of ______________ Physics.
(ii) The slope of a straight line of Distance-Time graph represents ____________
(iii) Vectors are added graphically by using ______ _______ rule.
(iv) The rate of change of velocity of a body is called _______________.
(v) When an external force acts upon a body it produces an _____________ in the body in its own direction.
(vi) If the centre of gravity of a body lies at the point of suspension or support, the body is said to be in the state of ____________ equilibrium.
(vii) The attractive force between any two bodies of the universe is called ________________.
(viii) The weight of a body becomes ___________ it it is taken at a distance double the radius of the earth from the centre of the earth.
(ix) The unit of power in SI units is the _________ __ which is the same as ________ per second.
(x) The property of the matter by virtue of which it resists any force that tends to produce deformation in it is called ____________.

Q2. Given below are a few possible answers to each statement, of which one is correct. Identify the correct one.

(i) The founder of algebra, a famous Muslim Scientist born in 780 was ______
   (a) Al-Khawarzimi   (b) Al-Kindi
   (c) Al-Beruni    (d) Naseer-ud-Din Toosi

(ii) The fundamental unit of length in S.I. unit of measurement is ____________
   (a) kilometer       (b) meter
   (c) yard            (d) foot
(iii) _____________ is a scalar quantity.
   (a) Displacement    (b) Force
   (c) Speed           (d) Velocity

(iv) The velocity and acceleration of a body moving with uniform speed in circle
     are ______________.
   (a) parallel    (b) opposite
   (c) mutually perpendicular (d) in same direction

(v) Friction can be reduced by using ball bearings because they ____________.
   (a) make the surface plane    (b) make the surface grassy
   (c) convert sliding friction into rolling friction
   (d) have no friction of their own.

(vi) Torque about an axis is defined as the product of
   (a) mass and force
   (b) force and moment arm
   (c) mass and acceleration

(vii) If the mass of body moving in a circle with a uniform speed, is doubled then
      its centripetal force becomes.
   (a) twice    (b) three times
   (c) four times    (d) eight times

(viii) Work is done when a body is moved through a distance by a ________.
   (a) fulcrum    (b) inclined plane
   (c) mechanical advantage (d) force

(ix) A pair of scissors is an example of a ______________
    (a) pulley    (b) lever
    (c) wheel and axle (d) inclined plane

(x) The molecular theory of matter was experimentally testified by ____________.
    (a) Hooke    (b) Archimedes
    (c) Brown    (d) Pascal
Government Comprehensive High School Jhelum

First Term Test Physics (Theory) Class X

Name _____________________________________ Roll No. _____________
Max Marks: 75 Time: 2:30Hrs.

Part II

Note: Attempt any five questions.

Q1. (a) What is Physics? Name five branches of physics and describe them.

(b) Write names of seven fundamental units and seven derived units with their symbols in International system of units.

Q.2 (a) Define scalar and vector quantities. Give five examples of each.

(b) A force of 100 N acts at an angle of 30° with the horizontal. Find its horizontal and vertical components.

Q3. (a) State Newton’s three laws of motion, giving example from every day life.

(b) Determine the acceleration of a 72kg skater, when an unbalanced force of 144N acts on him.

Q4. (a) Explain what is meant by centripetal force. Give three examples of a body moving in a circular path.

(b) What is the mass of an object that is pulled down by a force of gravity of 29.4 N at the surface of earth?

Q5. (a) Define work, power, energy and their units in SI systems.

(b) A force of 588N acts on a box to move it 4m in 40 seconds. Calculate the Power.

Q6. (a) What is a leaver? Determine its mechanical advantage.

(b) A lift carrying 120kg weight of bricks travels to the top of a building 10m high, calculate the energy used.

Q7. (a) Explain the three states of matter on the basis of molecular theory.

(b) Define Pascal’s law. Explain its application in hydraulic press.
Government Comprehensive High School Jhelum

Practical Examination

(First Term Test Physics Class X)

Name _______________________________ Roll No. _____________

Max Marks: 25 Time: 1:30Hrs.

Note: Perform any one experiment.

A. Determine the diameter of a wire by using screw gauge. (20)

OR

Find the value of ‘g’ by free fall method.

B. Note book (3)

C. Viva Voce (2)
Government Comprehensive High School Jhelum

Second Term Test Physics (Theory) Class X

Name _______________________________ Roll No. _____________

Max Marks: 75 Time: 2:30Hrs.

Part I

Q1. Fill in the blanks.

(i) 32°F is the same temperature as _____________ °C and ___________ °F is the same temperature as 100°C.

(ii) Transverse waves consist of ______________.

(iii) The image formed by a ________ mirror is always virtual, erect and smaller than the object.

(iv) A lens through which the rays after refraction converge at a point is called ___________ lens.

(v) The unit of power used by opticians is called a ________________.

(vi) Coulomb is defined as the amount of charge carried by a current of ________ in ___________ second.

(vii) If an electric current is passing through a wire then a __________ is produced around it.

(viii) Ammeter is an electrical instrument used for measuring ________________.

(ix) When a semiconductor diode is reverse biased, electrons and holes will move ___________ the p-n junctions.

(x) A reaction in which __________ nucleus splits in to fragments is called ____________.

Q2. Given below are a few possible answers to each statement, of which one is correct. Identify the correct one.

(i) When water is changed into ice, it ________________.
   (a) expands     (b) contracts
   (c) becomes heavy (d) becomes dense

(ii) In transverse waves the distance between two consecutive crests or between two consecutive troughs is called ____________.
   (a) displacement   (b) wave length
   (c) velocity    (d) speed
(iii) If the inner surface of a spherical mirror is reflecting it is called __________
mirror.
(a) plane mirror    (b) concave mirror
(c) convex mirror

(iv) A convex lens is ______________
(a) thinner at the centre    (b) thicker at the centre
(c) a diverging lens (d) plane throughout

(v) A single diverging lens is used in ____________
(a) a magnifying glass    (b) a camera
(c) the objective lens in a telescope    (d) spectacles for the correction of short-sightedness.

(vi) The commercial unit of electric energy is known as ____________
(a) ohm    (b) volt
(c) ampere x second    (d) kilo-watt-hour

(vii) The relation between electric current and the magnetic field was discovered by ____________
(a) Newton    (b) Faraday
(c) Fleming    (d) Oersted

(viii) The measure current in a circuit an ammeter is always connected ____________
(a) in series    (b) in parallel
(c) in any way    (d) parallel to voltmeter

(ix) The frequency of audio waves lies in the range ____________
(a) 20 to 20 KHz    (b) 30 KHz to 30 MHz
(c) 20 KHz to 200 KHz    (d) 200 KHz to 2000 KHz

(x) X-rays are found to be ____________
(a) Electromagnetic waves    (b) electrons
(c) Fast moving neutron    (d) fast moving helium nuclei.
Government Comprehensive High School Jhelum

Second Term Test Physics (Theory) Class X

Name ________________________________  Roll No. _____________

Max Marks: 75  Time: 2:30Hrs.

Part II

Note: Attempt any five questions.

Q1. (a) Define heat and temperature and also describe various scales for the measurement of temperature.
   (b) Define co-efficient of linear expansion and derive the following equation.

Q2 (a) Explain the difference between transverse and longitudinal waves.
   (b) Find the time period of a simple pendulum whose length is 144 cm.

Q3. (a) Define reflection of light, state the laws of reflection.
   (b) An object is placed at a distance of 30 cm from a concave mirror. It’s focal length 5 cm. If the object is 5 cm high, find the position and size of image.

Q4. (a) Explain the functions of human eye. Name its different parts.
   (b) What are the main defects of a human eye?

Q5. (a) State coulomb’s law and define the unit of charge.
   (b) Explain series and parallel combination of resistances.

Q6. (a) Describe fission process in detail.
   (b) Half life of radon is 3.82 days. How much of a 100 grams sample of radon would be left after 7.64 days.

Q7. (a) What is the difference between conductor, non-conductor and semi-conductors?
   (b) What are N-type and P-type semi-conductors, explain?
Government Comprehensive High School Jhelum

Practical Examination

(Second Term Test Physics Class X)

Name _______________________________ Roll No. _____________

Max Marks: 25 Time: 1:30Hrs.

Note: Perform any one experiment.

A. Verify the laws of refraction of light by using a glass slab. (20)

   OR

   Plot the magnetic field due to a bar magnet.

B. Note book (3)

C. Viva Voce (2)
Board of Intermediate and Secondary Education Rawalpindi

SSC Examination 2005

Max. Marks: 15      Time allowed: 20 minutes

Physics           Group-I

Note: Four possible answers are given for each of the following statements.
Encircle the correct answer.

PART-I (Objective type)

A.

(i) Rate of change of velocity is known as __________.
   (a) Displacement   (b) Acceleration  
   (c) Relative Motion   (d) Distance

(ii) A ball is dropped from the top of the tower. The distance covered by it in the first second is ____________.
    (a) 100m   (b) 10m  
    (c) 50m   (d) 5m

(iii) The acceleration produced in a moving body is always in the direction of ____________.
     (a) velocity   (b) force  
     (c) momentum   (d) speed

(iv) What is the unit of power in System international?
     (a) newton   (b) watt  
     (c) joule   (d) meter

(v) When water changes into ice, it
    (a) contracts   (b) expands  
    (c) becomes dense   (d) remains the same

(vi) Which material is better for insulation
     (a) glass   (b) Air  
     (c) fibre glass   (d) Brass

(vii) The instrument which stores charge is known as
      (a) electroscope   (b) conductor  
      (c) capacitor   (d) capacitance
(viii) The shape of magnetic lines of force in case of a straight current carrying conductor is
(a) elliptical   (b) triangular
(c) rectangular   (d) circular

(ix) In a n-type crystal, the majority carriers are_______.
(a) holes     (b) free electrons
(c) protons   (d) positrons

(x) If the image is virtual, then its distance from lens is taken as
(a) positive     (b) negative
(c) double   (d) Zero

B. Match the unit with the quantity and write the answer is column C.

<table>
<thead>
<tr>
<th>Column-A</th>
<th>Column-B</th>
<th>Column-C</th>
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</thead>
<tbody>
<tr>
<td>1-force</td>
<td>m/s</td>
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<tr>
<td>2- acceleration</td>
<td>V</td>
<td></td>
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<tr>
<td>3- energy</td>
<td>J</td>
<td></td>
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<tr>
<td>4- pressure</td>
<td>Ohm</td>
<td></td>
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<td>5- speed</td>
<td>N</td>
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<td></td>
<td>N/m²</td>
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<td></td>
<td>m/s²</td>
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</table>
PART-II (Subjective)

Note: Attempt any two questions from each section. All question carry equal marks.

SECTION-I

Q.1 (a) Define the following terms: Velocity, acceleration, uniform speed, and displacement.
(b) Drive second equation of motion.
(c) The velocity of a train increases from 10m/s to 20m/s in one minute. What will be its average velocity during this time? How much distance will it cover during this time?

Q.2 (a) Differentiate between mass and weight.
(b) State and explain the conditions of equilibrium when a number of forces are acting on it.
(c) A cyclist weighing 800 N moving along a circular track with a velocity of 20m/s. If the radius of the circle is 20m; find the centripetal force acting on the cyclist.

Q.3 (a) Find the mass of earth by using Newton law of gravitation.
(b) Define work, power and energy. Drive equation of Kinetic Energy of a moving body.
(c) Explain Pascal’s law with the help of two examples.
SECTION-II

Q.4 (a) Define Simple Harmonic Motion (SHM) and prove that vibrating motion of mass attached to a spring is SHM.

(b) Distinguish between noise and musical sound. Mention the characteristics of musical sound.

(c) Drive concave mirror formula.

Q.5 (a) Explain Coulomb’s law and write it in the mathematical form.

(b) How are resistance connected in series?

(c) Drive concave mirror formula.

Q.6 (a) How the number of electrons and holes can be increased in a semiconductor?

(b) What is radio isotope? How these isotopes help us in our daily life?

(c) The half life of radium is 1600 years. How much of 120 gram of radium will be left after 4800 years?
Appendix – C

Dear Students,

I am administering you a tool, which will assess the scientific attitude of the students. Your participation in this regard is earnestly needed and will highly be appreciated. Thanks a lot.

Muhammad Safdar
Ph. D Scholar

INSTRUCTIONS: Indicate by a check (√) your degree of agreement in each statement on five-point scale. These are as under:

5. Strongly Agree (SA)  4. Agree (A)  3. Undecided (U)
2. Disagree (D)  1. Strongly Disagree (SD)

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Domain</th>
<th>Statements</th>
<th>SA</th>
<th>A</th>
<th>U</th>
<th>D</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Curiosity</td>
<td>Students who are keen to learn new ideas despite their inadequate knowledge are likely to become scientists</td>
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<td>2</td>
<td>Use of computer in the teaching and learning have nothing to do with scientific behavior</td>
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<td>3</td>
<td>Seeking further information about a novel situation is considered a sound approach to begin with.</td>
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<td>4</td>
<td>Questioning opinion and ideas have nothing to do with scientific behaviour.</td>
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<td>5</td>
<td>Open mindedness</td>
<td>It is worthless to listen to a new idea unless all people accept it.</td>
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<td>6</td>
<td>Listening to new ideas is a very interesting activity for me.</td>
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<td>7</td>
<td>The editor of well-known journal should not accept for publishing studies of beginners.</td>
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<td>8</td>
<td>One should be willing to change his idea if enough evidence shows that one’s idea is poor.</td>
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<td>9</td>
<td>Rationality</td>
<td>Knowledge is promoted if every new idea is accepted immediately after it is reported.</td>
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<td>10</td>
<td>One should not criticize the work of others.</td>
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<tr>
<td>11</td>
<td>It is better to accept the traditional beliefs, when there is a conflict between traditional beliefs and scientific discoveries.</td>
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<td>12</td>
<td>To develop the habit of reasoning in the students is wastage of time.</td>
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<td>Sr. No</td>
<td>Domain</td>
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<td>A</td>
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<td>D</td>
<td>SD</td>
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<tr>
<td>13</td>
<td>Courage</td>
<td>The work in the science lab is very dangerous that’s why I feel fear.</td>
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<td>14</td>
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<td>If one of our ideas is poor, we should hold this idea although it is proved to be poor.</td>
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<td>15</td>
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<td>Scientists present the knowledge as it is but not as the people like.</td>
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<td>16</td>
<td></td>
<td>Scientist’s knowledge has aesthetic value because the scientist seeks for truth and truth is beauty.</td>
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<tr>
<td>17</td>
<td>Objectivity</td>
<td>Enough evidence supporting a certain idea should be provided before the idea is accepted.</td>
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<td>18</td>
<td></td>
<td>Knowledge once accepted is not subject to change.</td>
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<td>19</td>
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<td>The records of the observation of the scientist reflect the personal feelings of the scientist.</td>
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<tr>
<td>20</td>
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<td>A successful scientist is more objective than a politician.</td>
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<tr>
<td>21</td>
<td>Aversion to</td>
<td>Scientific explanation should be preferred to the romantic stories of astrologers and magicians.</td>
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<td>22</td>
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<td>Scientist can predict the weather with high probability.</td>
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<td>23</td>
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<td>Traditional beliefs should be preferred even harmful.</td>
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<td>24</td>
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<td>For weather predictions, magicians and astrologers should be consulted.</td>
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<td>25</td>
<td>Miscellaneo</td>
<td>We should not plan our future because future will take care of itself.</td>
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<td>26</td>
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<td>We should prepare our-self before entering into the science laboratory.</td>
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<td>27</td>
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<td>Experimental work is nothing but wastage of resources/ (time, money, labour).</td>
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<td>28</td>
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<td>Knowledge should be considered tentative.</td>
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The calculation of t-value for evaluating the difference in the mean response to an attitude statement by High and Low achievers. 
(N= 100, for a favourable statement).

<table>
<thead>
<tr>
<th>Response Categories</th>
<th>High achievers (X_H)</th>
<th>Low achievers (X_L)</th>
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\[
X_H = \frac{240}{50} = 4.8 \quad \quad \quad X_L = \frac{175}{50} = 3.5
\]

\[
S_H = \frac{X_H^2 - (\sum X_H)^2}{N} = \frac{1160 - (240)^2}{50} = 8.0
\]

\[
S_L = \frac{X_L^2 - (\sum X_L)^2}{N} = \frac{685 - (175)^2}{50} = 72.5
\]

\[
t = \frac{X_H - X_L}{\sqrt{\frac{S_H^2 + S_L^2}{N(N-1)}}} = \frac{4.8 - 3.5}{\sqrt{\frac{8 + 72.5}{50(50-1)}}} = 2.3
\]

The calculated t-value (2.3) is greater than tabulated t-value. Therefore, this statement included in the attitude questionnaire.
Appendix – D

EXPERIMENT NO. 1
POST LAB “MEASURING CYLINDER”

Q1. Read the statements carefully and tick the most suitable option:

1) Measuring cylinder is used to measure:
   a) weight of liquid
   b) volume of liquid
   c) mass of liquid
   d) density of liquid

2) If there is a direct proportion between two variables then the graph will be:
   a) a curve
   b) a circle
   c) a U shape
   d) a straight line

3) The relationship between mass and volume \((m/V)\) is called:
   a) pressure
   b) weight
   c) stress
   d) density

4) Volume of the solids is measured in \(cm^3\) and liquids in ml. which one relation is true?
   a) \(1 \text{ ml} = 1 \text{ cm}^3\)
   b) \(1 \text{ ml} = 10 \text{ cm}^3\)
   c) \(1 \text{ ml} = 100 \text{ cm}^3\)
   d) \(1 \text{ ml} = 1000 \text{ cm}^3\)

Q2 Give the short answers:

1) Differentiate between mass and volume?

2) Define Independent and dependent variable along with one example?

3) Why is it necessary to select a suitable scale to plot a graph?
Q1. Read the statements carefully and encircle the most suitable option:

1) The least count of a vernier caliper is 0.01 cm? What is the least count of a meter rod?
   a) 0.1 cm                b) 0.01 cm
   c) 0.001 cm              d) 1.00 cm

2) The inside jaws of a vernier caliper is used to measure _________________.
   a) internal diameter      b) external diameter
   c) depth                  d) none of a, b, c

Q2 Give the short answers to the question given below:

1) Why is vernier callipers considered better as compared to a meter rod?
   ________________________________________________________________
   ________________________________________________________________

2) Find out the volume of the given dice with the help of vernier callipers and verify it by using measuring cylinder.

3) Name the instruments in which vernier are used most commonly.
Q1. Read the statements carefully and encircle the most suitable option:

1) What is the least count of a screw gauge?
   a) 0.1 mm   b) 0.01 mm
   c) 0.001 mm  d) 1.00 mm

2) What is the volume of a ball having radius 1m?
   a) $\frac{1}{4} \pi$  b) $\frac{3}{4} \pi$
   c) $\frac{4}{3} \pi$  d) $2\pi$

Q2. Give the short answers to the question given below:

- What does the pitch of a screw gauge mean?

- Measure the thickness of all the pages of your practical notebook and then find the thickness of one page in mm?
Q1. When a constant force is acting on a body, the acceleration produced is:
   a) uniform   b) angular
   c) variable   d) negative

Q2. The acceleration of a free falling body is:
   a) constant   b) angular
   c) variable   d) negative

Q3. What is the difference between ‘a’ and ‘g’?

Q4. Plot a graph between ‘S’ and ‘t^2’ by taking ‘S’ along x-axis and ‘t^2’ along y-axis. Is it a straight line?
EXPERIMENT NO. 5

POST-LAB “DETERMINE THE MECHANICAL ADVANTAGE (M.A) OF AN INCLINED PLANE”

Q1. An inclined plane 5m long has one end raised by 1m. The efficiency of the inclined plane (machine) is 40%:
   a) What is the minimum effort required to raise a 100N load up the plane
   b) What will be the effort if the plane is perfectly smooth?

Q2. Which inclined plane has the greater M.A? a, b or c.

Q3. What is the unit of M.A?

Q4. On what factors the M.A of an inclined plane depends?

Q5. Keeping in view the concept of inclined plane which sandal has greater M.A?
EXPERIMENT NO. 6
POST LAB “PRINCIPLE OF MOMENTS”

Q1 Give the short answers to the question given below:

1) What is the difference between rest and equilibrium?

___________________________________________________ _____________________

___________________________________________________ _____________________

___________________________________________________ _____________________

2) Is torque a scalar quantity or vector quantity?

___________________________________________________ _____________________

___________________________________________________ _____________________

___________________________________________________ _____________________

3) Why is it better to place a meter rod on a wedge edge wise rather than keeping in flat on the edge?

___________________________________________________ _____________________

___________________________________________________ _____________________

___________________________________________________ _____________________

4) Find out the center of gravity of the given meter rod by balancing it on a wedge. Suspend a weight, which is already known, and a pebble of unknown weight with the help of thread and balance rod again. Find out weight of the pebble by principle of lever?

___________________________________________________ _____________________

___________________________________________________ _____________________

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EXPERIMENT NO. 7
POST LAB “ADDITION OF VECTORS”

Q1 Read the statements carefully and encircle the most suitable option:

i) Which quantity is scalar?
   a) Force       b) Weight
   c) Work        d) Friction

ii) Which one is vector quantity?
    a) Mass       b) Temperature
    c) Momentum   d) Time

iii) Two forces of 3 N and 4 N or acting on a body the angle between them is 90°. The resultant force will be:
    a) 1 N       b) 5 N
    c) 7 N       d) 10 N

Q2. A ring is tie up with three strings shown in the figure. The angle between two strings is of 60° and each one is pulling the ring in the upward direction with the force of 4 N. To make the ring in equilibrium how much force is required?

![Diagram of a ring with three strings pulling in upward directions]
Q1. Read the statements carefully and encircle the most suitable option:

i) Which one is more elastic?
   a) Air  b) Water  c) Rubber  d) Metal

Q2. Give the short answers to the question given below:

i) What is difference between stress and pressure?

ii) Write down the names of all kinds of strain?

iii) Why does elastic strap of trousers loose after a few days?

iv) If a pebble stone is placed in a catapult and the rubber band of the catapult are stretched and then released why does the pebble fall for away?
EXPERIMENT NO. 9

POST LAB “CENTER OF GRAVITY”

Q1. Read the statements carefully and encircle the most suitable option:

i) Where lies the center of gravity of a freely hanging object?
   a) Above the hanging point   b) Below the hanging point
   c) On the right side of a hanging point   d) On the left side of a hanging point

Q2. Give the short answers to the question given below:

i) Can a body in motion be in a state of equilibrium? Explain with an example?

_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________

ii) Does the center of gravity of an object lie inside it?

_________________________________________________________________________
_________________________________________________________________________
_________________________________________________________________________

iii) When do we consider a body to be in a state of equilibrium?

_________________________________________________________________________
_________________________________________________________________________
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EXPERIMENT NO. 10

POST-LAB “THE SIMPLE PENDULUM”

The following questions will help you to consolidate the work you did in the lab and help us to improve the teaching – learning process in the lab.

(Part A) (6x1 = 6)

Read the statements carefully and tick (✓) the correct answer.

1. The time-period of second pendulum is:
   (a) 0.02 sec.   (b) 0.2 sec.   (c) 2.0 sec.   (d) 2.2 sec.

2. A simple pendulum is made of plastic ball (as a bob) filled with water and have a hole in it. During the oscillation, due to the flow of water, its mass decreases. What will be the effect on the time-period of the pendulum? (Law of mass of simple pendulum)
   (a) It will increase   (b) It will decrease
      (c) It will remain same   (d) none of the, a, b, c.

3. If the bob of the pendulum of given length is replaced by another bob of different material what will be the effect on the time-period of the pendulum?
   (a) It will increase   (b) It will decrease
      (c) It will remain same   (d) none of the, a, b, c.

4. If the oscillation of a simple pendulum of a given length became small. What will be the effect of smaller oscillations on the time-period of the pendulum? (Law of isochronisms)
   (a) It will increase   (b) It will decrease
      (c) It will remain same   (d) none of the, a, b, c.

5. If we decrease the length of the simple pendulum. What will be the effect of length on the time-period of the pendulum? (Law of length)
   (a) It will increase   (b) It will decrease
      (c) It will remain the same   (d) none of the, a, b, c.
(Part B)

Write the short answers (on the space given below) of the following questions.

1. Will a pendulum of a clock that keeps correct time at Karachi, be accurate at the mountain K2.

____________________________________________________________________________________

____________________________________________________________________________________

2. Give two examples of motion’s that are simple harmonic.

____________________________________________________________________________________

____________________________________________________________________________________

(Part C)

By using formula $T = 2\pi \sqrt{\frac{l}{g}}$. Find the value of $g$ by taking the mean length (l) and the time-period (T) from your experiment you have just done. Is it 9.8 m/s$^2$ (approximately)?
EXPERIMENT NO. 11

POST-LAB “DETERMINE THE SPEED OF SOUND AT ROOM TEMPERATURE BY USING RESONANCE TUBE”

Q1. Choose the best possible answer.
   (i) The tuning of a radio set is an example of the phenomena:
       (a) Reflection (b) refraction (c) diffraction (d) resonance
   (ii) Stethoscope is used to hear the heartthrob (beat) or the inhaling /exhaling air by the lugs. The phenomenon of sound involved is:
        (a) Reflection (b) refraction (c) diffraction (d) resonance

Q2. What is the effect of temperature on the velocity of sound?

Q3. What is the effect of Pressure on the velocity of sound?

Q4. What type of waves is produced in the air Column in the tube?

Q5. How echo is produced?

Q6. Explosions on the surface of the Sun are not heard on Earth why?
EXPERIMENT NO. 12

POST-LAB “OHM’S LAW”

Q1. Why we use voltmeter in parallel and ammeter in series in a circuit?

Q2. What is the function of voltmeter?

Q3. What are the units of voltage, current and resistance? Also write their symbols.

Q4. By using the readings taken from the experiment, draw a graph between the voltage and current. Is it a straight line?
EXPERIMENT NO. 13

POST LAB “MAGNETIC LINES OF FORCE”

Q1. Which things are attracted by a magnet?
(a) things made of iron       (b) things made of nickel things
(c) made of cobalt           (d) all of the a,b,c

Q2. Magnetic lines of force pass easily through.
(a) air        (b) water
(c) wood       (d) iron

Q3. What is an electromagnet?

Q4. Can north and earth poles of a magnet be separated?

Q5. With the help of the apparatus given to you, make an electromagnet. By using left hand rule find magnetic polarity and the direction of the current.
EXPERIMENT NO. 14

POST-LAB “FIND THE DENSITY OF A SOLID BODY HEAVIER THAN WATER BY ARCHIMEDES PRINCIPLE”

Answer the following questions?

Q1. What is use of hydrometer?

Q2. On what factors up thrust/ buoyant force depends?

Q3. Why buildings and heavy things move easily during flood?

Q4. Why does a small stone sink in water while a ship with a huge weight floats?

Q5. Why it is difficult to drown in the “dead sea” as Compared to a swimming pool?
EXPERIMENT NO. 15

POST-LAB “STUDY THE CHARACTERISTICS OF P-N JUNCTION (DIODE)"

Q1. Tick the correct answer.

*If we increase the temperature of the conductor its resistance will:*

(a) Increases (b) decreases (c) remains same (d) none of a,b,c

Q2. Write two uses of diode?

Q3. A junction diode always allows electric current to pass through it in one direction only. How?

Q4. Show diagrammatically the half and full wave Rectification.
EXPERIMENT NO. 16

POST-LAB “TRUTH TABLE OF OR & AND GATES”

Q1. Define logic gate.

Q2. What is meant by truth table?

Q3. What are the characteristics of AND gate?

Q4. Write two uses of logic gates?

Q5. Draw the logic symbol for AND gate and OR gate.
EXPERIMENT NO. 17
POST-LAB “LAWS OF REFRACTION”

Q1. Encircle the correct answer.
(i) In which medium the speed of light is greater?
   (a) air     (b) water
   (c) wood    (d) iron

(ii) The image formed on the film of a still camera.
   (a) small, virtual and erected   (b) small, real and erected
   (c) small, virtual and inverted  (d) small, real and inverted

(iii) The tank full of water looks less deep due to the phenomenon of:
   (a) reflection of light   (b) refraction of light
   (c) dispersion of light   (d) interference of light

(iv) If a light rays passes from air and strike perpendicularly on the
     surface of a glass, the angle of refraction will be :
   (a) 0     (b) 45
   (c) 90    (d) 30

Q2. Why does a pencil placed in water looks to be bend?

Q3. Write the name of any four instruments which work on the principles.
EXPERIMENT NO. 18

POST-LAB “FOCAL LENGTH OF A CONCAVE MIRROR”

Q1. Encircle the correct answer.
i. We always get virtual image from a:
   (a) concave mirror (b) concave lens
   (c) convex mirror (d) a,b,c

ii. Which one is diverging mirror?
   (a) concave mirror (b) plane mirror
   (c) convex mirror (d) a,b,c

iii. To see the rear traffic on the road, drivers used the:
   (a) concave mirror (b) plane mirror
   (c) convex mirror (d) a,b,c

iv. To see the traffic on the blind turn, drivers used the:
   (a) concave mirror (b) plane mirror
   (c) convex mirror (d) a,b,c

Q2. Write the name of four instruments in which concave mirror is used.

Q3. What is parallax?

Q4. An object is placed at a distance of 10 cm from a concave mirror. If the radius of curvature of the concave mirror is 15 cm, determine the position, nature and magnification of the image.
Q1. Encircle the correct answer.
i. We always get virtual image from a :
   (a) concave mirror  (b) concave lens
   (c) convex lens    (d) a,b,c

ii. Which one is converging lens?
   (a) biconcave lens (b) Plano-concave lens
   (c) biconvex lens  (d) none of a,b,c

Q2. Write the name of four instruments in which convex lens (es) is (are) used.

Q3. Define power of lens and also write its unit.

Q4. A person cannot see the distant objects clearly but can see near objects clearly. What is this defect, and how it can be removed?

Q5. In the experiment you have calculated the focal length of the convex lens. Can you tell its power?
Q1. Which one is used to disperse the white light into seven colours?

Q2. By which phenomena of light, rainbow is seen?

Q3. What are the optical fibers? On which principle they work? Describe their two main uses.

Q4. Describe total internal reflection and conditions necessary for it.
Appendix- E

1. **Dr. Muhammad Waseem**  
   Assistant Professor,  
   Allama Iqbal Open University,  
   Islamabad.

2. **Dr. Iqbal Shah,**  
   Assistant Professor,  
   Department of Science Education,  
   Faculty of Education, Block No. 10,  
   AIOU, Islamabad.

3. **Muhammad Tanveer Afzal**  
   Lecturer,  
   Secondary Teacher Education Department,  
   Allama Iqbal Open University,  
   Islamabad.

**SUBJECT:**  
**VALIDATION OF EXPERIMENTER’S TOOLS**

Muhammad Safdar is a Ph. D Scholar and administering different tools  
(tests and attitude scale) to the sample selected for this study.  
  
Please look into the effort done by the scholar and suggest improvements  
to make the tools valid.

Yours sincerely,

Dr. Tayyab Alam Bukhari,  
Associate Prof.  
College of Liberal Arts & Science,  
Foundation University, Rawalpindi.
Subject: VALIDATION OF EXPERIMENTER'S TOOLS.

Reference to the subject, the committee has thoroughly gone through “The Experimenter’s tools and attitude questionnaire.” The validity of instruments has also been checked according to our Social and Cultural set-up. It is also certified that changes made will not affect the essence of instruments.

Thanks.

Committee Members

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