CHAPTER – I

INTRODUCTION

1.1. PREAMBLE

Our quality of life and economy in future years depends on optimum utilization of the available learning resources. Students need a training ground to sharpen their existing skills, acquire new skills, conceive of and experiment with new ideas and enhance the inquisitive attitude level. Today's children are tomorrow’s citizens and hence the beginning should be made from the early stages of education itself.

To the majority of people, quality education ensures a comfortable and secure life. It is expected that education provides hope and opens avenues for a prosperous life. It should create intelligent hard working and productive men and women. Education should enable youngsters to become contributing members of the society through knowledge, skills and character development; provide access to the best training for people of all ages and backgrounds and make it possible for them to compete in a global economy. To achieve this, our courses and syllabi should emphasize relevance and applications to the real world. In a knowledge based society the content and process of education has to undergo continuous reorganization and upgradation. Unless the system of education works properly, all the ambitious programme of educational reforms envisaged in the National policy on Education 1986 will come to nothing. So we need a radical change of the system.
The learning of Physics on the basis of Mathematics alone can provide a basic preparation for full participation in a society. It will offer an entry into a wide array of career choices. Therefore from the social point of view, competence in physics with Maths background has become a requisite for successful career in industry, technology, engineering and other related fields. So importance should be given to Physics in the school curriculum in the present era. Children with special abilities are in great demand because India needs a host of creative scientists, innovative planners, intuitive teachers and intelligent politicians.

“Excellence in high school Physics depends on many things: the teacher, course content, availability of apparatus for laboratory experiments, a clear philosophy and workable plan for meeting students’ needs, serious dedication to learning goals, and adequate financial support. The role of the teacher, however, is the most important. Without a well-educated, strongly motivated, skilled, well-supported teacher, excellence in high school Physics would be only in paper. The teacher is the keystone of quality.” Educational research has continued to show that an effective teacher is the single most important factor in student learning (Darling-Hammond, 2000; Marzano, 2007). Marzano characterizes an effective teacher as one who matches strategies to students.

1.2. AIMS AND OBJECTIVES OF THE CURRICULUM

An effective curriculum in physics should:

1. Draw out, excite, cultivate and inspire the complete development of all the pupils.
2. Bridge the gulf between the school subjects and the varied complex of activities that makes up the warp and woof of life.

3. Develop the character of pupils by developing in them the qualities of honesty, integrity, friendliness, goodwill, judgment and cooperation.

4. Enable pupils to establish values through intimate contact with arts, religions, social sciences, natural sciences and humanities.

5. Create a community of scholars who may advance the frontiers of research, enquiry and knowledge.

6. Meet the needs of all types of pupils having different tastes, abilities, capacities, interests and aptitudes.

7. Create an atmosphere where students may learn to think and develop their faculties of thinking, reasoning and observing.

1.3. INSTRUCTIONAL STRATEGIES

Since the inception of formal, classroom-based instruction, a fundamental aspect of teaching has been innovated so that the teachers arrange the classroom environment in and out to make the students interact and learn. The instructional strategies devised by teachers help and shape the learning environment and embedded particular professional conceptions of learning. Some strategies consider students as empty vessels to be filled under the firm direction of the teacher; other strategies regard them as active participants in the process of learning through inquiry and problem solving, still others tell children that they are social organisms learning through dialogue and interaction with others.
Science education is a complex process which in its simplest form involves teacher instruction, student learning and a science curriculum. Though this study is focused on specific problems in teaching grade 12 Physics, the outcomes have general relevance to science teaching at all grade levels.

1.4. INSTRUCTION - MEANING

According to Bodhidharma, “To enter by reason means to realize the essence through instruction and believe that all living things share the same true Nature, which isn’t apparent because it’s shrouded by sensations and delusions.

1.5. THE DIFFERENCE BETWEEN TEACHING AND INSTRUCTION

Teaching is to explain how and what is done, while ‘instruction’ is telling how something is done. These two go hand in hand together but are often confused since they are almost similar in meaning.

Teaching is more complex in Nature. When we talk about teaching, we are dealing with different techniques, strategies and approaches that will facilitate learning. Teachers have to come up with varied instructional materials and must use the right strategies in teaching their lessons.

Teaching is also a never ending process. From the time individuals start – going to school to the time they graduate and start working, they are involved in the teaching-learning process. They learn not only from teachers but also from those around them.

This makes teaching both formal and informal. It is formal when it occurs inside the classroom or informal when the students learn things outside the portals of the school. For instance, they learn to read and write in school with the help of their
teachers. Also, their parents teach them informally about living life and correct values. When we talk about ‘instruction’, it’s not as complex as ‘teaching’. Instruction is simply giving directions. Teachers instruct the students on what to do or how to perform an experiment. After that they are simply left to do their work on their own.

Instruction makes learners dependent on the teacher. They are told what to do and oftentimes, there are steps they need to follow. Instructions must be understood and strictly followed in order to accomplish a particular task. Once they fail to do so, they won’t be able to finish the task correctly. Teaching and instruction go together especially in education. Both are needed in helping people learn and develop as individuals.

1.6. INSTRUCTIONAL MODELS

1.6.1 Teaching Content and Thinking Skills

An instructional model acts as blue print for teaching, however, just as blueprints do not dictate all actions of engineers, instructional models are not intended to dictate the actions of teachers. Teachers must select the appropriate model in order to achieve a specified goal, just as engineers select appropriate designs or methods based on desired outcomes. Models differ from general teaching strategies because they are designed to reach specific goals. In fact, instructional models generally include a variety of instructional strategies. (Eggen&Kauchak, 2001)
The sample instructional models outlined below, designed to help students learn content and develop thinking skills, include many high-yield instructional strategies identified by Robert Marzano (2001) and his colleagues.

1.6.2 Integrative Model

In the Integrative model, students develop a deep understanding of organized bodies of knowledge while developing critical thinking skills. The model is designed to teach combinations of concepts, generalizations, principles, rules, facts and the relationships between them, typically through the use of matrices which may be either teacher or student-generated, depending on student readiness. ex.’s. a chart comparing characters in a literary work in terms of personal attributes, conflict and symbolism. Students are expected to do the following: describe, compare and search for patterns; explain similarities and differences; hypothesize outcomes for different conditions; and generalize to form broad relationships.

1.6.3 Social Interaction Model

The social interaction model involves students working collaboratively to reach common goals, increasing learner involvement and providing leadership opportunities and decision-making experiences. It takes various forms including group work. (ex. think-pair-share, pairs check and combining pairs), co-operative learning (ex. student teams achievement division, jigsaw and group investigation) and discussion.
1.6.4 Inductive Model

In the inductive model, students use information that illustrates concepts to search for relationships that lead to uncovering of principles, generalizations, and rules, this enables them to acquire a deeper understanding of concepts. Illustrations may include concrete materials, pictures, models, case studies, simulations and role play. The Inductive model is based on the view that learners construct their own understanding of the world rather than record it in an already – organized form.

1.6.5 Concept – Attainment Model

Using examples and non-examples to illustrate concepts, the concept-attainment model employs inductive strategies to help students reinforce their understanding of concepts and practise hypothesis testing. As additional examples and non-examples are examined, students analyze possible hypotheses. Students then isolate a hypothesis and form a definition. In the final phase of the model, students analyze additional examples based on the definition.

1.6.6 Concept – Development model

The concept development model builds on students’ prior knowledge and refines and extends concept information so that students can understand increasingly complex and abstract ideas. Students list, group, and regroup items related to a subject, verbalizing common attributes and revealing thought patterns. Students label the groups, draw inferences, and make generalizations from the specific data available to them. Finally, creating a one-sentence summary about each of the groupings, students demonstrate understanding of multiple relationships.
1.6.7 Problem – Based Model

The problem – based model is designed to teach problem – solving skills and content and to develop self – directed learning. The model uses a problem or a question as a focal point for students attention problem – based learning is a broad family of teaching models that includes problem solving, inquiry, project-based learning and case-based learning.

1.6.8 Direct - Instruction model

With emphasis on active teaching and high levels of student involvement, the direct instruction model focuses on both concepts and skills. In this model, the teacher structures the topic, explains it to students, provides students with opportunities to practices, and give feedback. Control of learning gradually shifts from teacher to learners.

1.6.9 Lecture - Discussion model

The Lecture – Discussion model uses a teacher – centered approach to help students understand organized bodies of knowledge. Teachers use advanced organizers at the beginning of a lesson to preview and structure new material, linking it to students existing network of organized and inter connected ideas and relationships. These instructive models are to be viewed and a suitable scaffold selected for instructional approaches

1.7 APPROACH – MEANING

‘Approach’ means to bring near; to cause to draw near; to advance, To make a proposal or overtures to with a specific end in view
1.7.1 **Inductive Approach**

According to Joseph Landon, “we make use of the inductive method of teaching, whenever, we place before children a number of facts, examples or objects, and then endeavor to lead them to draw their own conclusions”.

Example; in teaching science, by heating various metals, the students may conclude that metals expand when heated.

This approach is suitable for the following

1. Where the rules are to be formulated
2. Where the definitions are to be framed
3. Where the generalizations are to be made or where general laws are to be arrived at
4. Where causal connections between facts are to be established.

1.7.1.1. **Steps involved in Inductive Approach**

1. Recognition of the Problem
2. Searching for Data
3. Organization of Data
4. Framing Hypotheses
5. Testing Hypotheses
6. Generalizations
7. Application and Verification
Merits

- It is in compliance with the maxims of teaching
- It is psychologically sound, as it involves learning by doing
- It promotes self-activity and interest
- It fosters independence and confidence
- It develops creative thinking and initiative
- It promotes self-acquired knowledge
- There is possibility of correlation in this approach

Demerits

- It is time consuming
- It is boring and lengthy
- It is energy consuming and requires much effort
- It is very expensive
- It is not suitable for higher studies
- It may yield wrong conclusions
- It is incomplete without deduction

1.7.2 Deductive Approach

According to Joseph Landon, “Deductive teaching secures first the learning of the definition or law or rule, then carefully explains its meaning and lastly illustrates it fully by appeal to facts”.

For example in the teaching of science, the action of the pump is explained under the general principle of atmospheric pressure.
1.7.2.1. Steps involved in Deductive Approach

1. Recognition of a Problem
2. Searching for and Collecting Data
3. Reviewing (Testing Hypotheses)
4. Formulations of inference or conclusion
5. Verification

Merits

- It saves time, money and energy
- It is useful during practice and revision
- It can be applied in higher studies
- The teacher’s work is implicated
- It enhances speed
- It glorifies memory

Demerits

- It encourages cram work
- It is not suitable for discovery
- It is not a natural and psychological approach because it does not depend upon activities. There is no self – activity.

The students must learn science subjects by the method of “learning by doing”. This can be achieved only through a proper use of the approaches and the methods suited for teaching science subjects. There are various approaches of teaching science subjects like inductive approaches, deductive approaches and Instructional approaches.
The Inductive approach of teaching science is a logical approach. It rests on systematic classification of facts followed by their proper organization, and the presentation of knowledge in an effective interesting manner. Deductive approach applies the conclusions, principles, and rules to particular new cases and derives rules from them or modified existing ones. As far as the Higher Secondary students of Physics are concerned, almost all the facts in Physics may appear to be appallingly difficult at learn to a few students.

1.8. INSTRUCTIONAL APPROACH IN PHYSICS

This approach envisages a more integrated curriculum that allows students to engage in the practices of physics, for example, asking questions, making observations, analyzing data, and constructing explanations. This will support and deepen their understanding of the principles and concepts of physics.

1.9. TEACHING APPROACH IN PHYSICS

According to Ali khan (1995), the pedagogic approach for sustainability necessitates a shift from a teaching to a learning paradigm that “emphasizes independence of mind and the ability to make sense of, rather than reproduce, information”.

Sterling (2001) addresses the different approaches and values of transmissive (transfer of information to learner) and transformative (learner constructing and owning meaning) methodologies that go beyond teaching methods to reflect the philosophy and purpose of education”.

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Until recently, research into learning and teaching has focused on what the teacher does rather than on what the learner does. However, recent research into student-learning indicates that what students do in order to learn is of greater importance.

Following on from hub research, educators have developed “learner-centered” or “student centered” pedagogy that has significantly influenced our understanding of learning and teaching.

As Thomas Shwell has said, student centered teaching is built on the assumptions that “what the students do is actually more important in determining what is learned than what the teacher does” (T.J. Shuell, 1986). Therefore, as an important part of our learning and teaching approach, UNSW emphasizes student centered and active learning approaches.

If teachers want student-centered learning activities to be effective, they should communicate the objectives, benefits and expectations to students so that they feel prepared and supported in their learning. In particular, students who are used to more traditional (teacher-centered) teaching will need this support.

1.10. TEACHING STRATEGIES IN PHYSICS

The following kinds of activities can be used to facilitate student-centered learning and teaching. These strategies are used to give students a chance to actively engage with the content and to provide variety within the lecture or tutorial.

- Brainstorming
- Case studies
- Debates
- Discussion
- Group work
- Questionnaire
- Simulation

1.11. TEACHING AND LEARNING INITIATIVE

Students’ at all academic levels benefit from alternative assignments and greater teacher attention in small – group activities that co-teaching makes possible. Co-teaching allows for more intense and individualized instruction in the general education setting increasing access to the general education curriculum while decreasing the edge of the stigma attended to students with special needs.

Students have an opportunity to increase their understanding and respect the needs of students with special needs. Students with special needs have a greater opportunity for continuity of instruction as the features benefit from the professional support and exchange of teaching practices as they work collaboratively.

Co-teaching involves two or more certified professionals who contract to share instructional responsibility for a single group of students primarily in a single classroom or workspace for specific content or objectives with mutual ownership, pooled resources and joint accountability.
1.12. THEORECTICAL ASPECTS

1.12.1 The Teacher

Mukherji (1957) observed that four terms are used to refer to the teacher, viz., 'Acharya', 'Guru' 'Sikshak' and 'Upadhyaya'. It may be noted that the term 'Acharya' was reserved by Patanjali for application to the highest type of teacher, an original thinker and master like Panini, while the other terms were used with reference to ordinary teachers.

To quote Gupta (1973), "As teachers, we tend to forget that our roles are determined to a large extent by the expectation of the pupils". One might ask what ideals or qualities a teacher should develop and possess so as to fit in with his changing roles. One cannot but recall the dictum laid down in the 13th Chapter of the 'BHAGAVADGITA' about the characteristics of a real teacher: absence of pride, freedom from hypocrisy, non-violence, forgiving Nature, straightforwardness, service of the preceptor, purity of mind and body, steadfastness and self-control. (Rao and Ramakrishnaiah).

1.12.2. The Teacher - Then and Now

The teacher in India has always been held in high esteem. Tradition has attributed to him certain desirable personal qualities which he will do well to cultivate in order to win and deserve that esteem. If the teacher is to secure and retain his rightful place, he has to accomplish all that he might with his pupils, and if he has to find satisfaction in his work, he must know the qualities and qualifications required and must strive to achieve them as far as possible. (Ramakrishnaiah, 1998)
Sayidain (1950) made the role of the teacher quite clear by saying that the teacher has to patiently cut from a crude and unshaped stone, proportion and balance. Altekar (1951) while explaining the status enjoyed by teachers in ancient India said that the teacher was paid the highest reverence by all people including the rulers. The teacher was called 'Guru' and 'Acharya' and was given the top most position in the professional hierarchy. (Ramakrishnaiah and Rao, 1998)

Sayidain further observed that we should take care to do nothing that will undermine the teachers’ dignity and self-respect. In this connection, there is a need not only for improving their material prospects but also according them proper social recognition which would cost the community nothing, except the cultivation of a better sense of values and greater social sensitiveness. (Ramakrishnaiah)

According to Apte (1961), the teacher in those days was not confronted with any financial problems. Mukerji (1957) stated that the teacher then had no need to worry his head over the mundane necessities of life, and hence was free to pursue his quest for knowledge. But today, the teacher finds himself handicapped not only by lower salary and lower status but also by longer hours of work and lack of facilities. (Rao, 1966).

Developments in teacher research have shown educator quality to be the most important influence upon student achievement. High quality professional development is essential to increase educator’s knowledge, skills, attitudes and beliefs so that they may enable all students to learn at high levels. Professional development that is most effective in improving educator practice is result oriented, data driven, constructive in Nature and job embedded. In this harsh environment a model teaching staff member should have the following competencies: Awareness
and understanding of the different ways in which students learn, knowledge, skills and attitudes relating to assessment and evaluation of students in order to help students learn, commitment to scholarship in the discipline, maintaining professional standards and knowledge of current developments, awareness of its applications to the discipline, the ability to access up to date materials and resources through the world wide web and other teaching technologies, sensitivity to external market signals as regards the need of those likely to employ graduates of the discipline, mastery of new developments in teaching and learning including the awareness of the requirements of “dual mode” tuitions with face to face and distance learning, customer awareness with regards to the views and aspirations of stakeholders including students, an understanding the impact international and multi-cultural factors would have on the curricula, ability to teach a divers range of students from different age groups socio-economic background, races etc, skills in handling larger numbers of students in formal lectures, seminars or workshops without the loss of quality, and development of personal and professional “coping strategies”.

1.13. TEACHER

The teacher’s role in the total educational process is vital as child’s behavior is greatly influenced by the teacher.

Alexander (1960) has outlined the characteristics of good teachers as follows:

- Concern for the individual
- Emotion
- Enthusiasm
• Intelligence
• Knowledge
• Personal charm
• Skill in Communication

A good teacher must be impartial.

1.13.1. Teaching – A Profession

Teaching is considered as a profession, when viewed from the internationally accepted yard stick. The National Education Association (NEA) of the US has given the following characteristics for a profession.

• Involves activities that are essentially intellectual.
• Commands a body of specialized knowledge.
• Demands continuous in-service growth.
• Affords a life career and permanent membership.
• Sets up its own standards.
• Exalts service above personal gains and possesses a strong closely knit professional organization.

When closely examined, it will be obvious that teaching has all these characteristics. Hence, it may rightly be called a full-fledged profession. In addition, profession can be adjudged from the following considerations too.

• The profession of teaching has well-defined functions, and well-identified Nature and scope.
• It has a philosophy of its own. In India it is a democratic educational philosophy.
• There is well-organized and recognized professional organization of teachers in the country at different levels of education. There are also federations of teachers in various levels and at national level.

• Teaching at present demands general and professional preparation.

The above points go to prove that teaching has gained the status of a profession.

1.13.2. Teacher as a Professional

Teaching is rightly being considered in present times as a profession and teachers have to play the roles of professionals. They have to become active members of their professional organizations, which strive to elevate their professional, social and economic status by trying to improve their service and salary conditions and also by providing welfare services to the teaching community, which also conduct research studies to help the advancement of professional knowledge and quality of practice, and which serve as common for a bringing all the professionals under one banner. The teacher should develop the requisite professional mindedness and act as a professional in and out of school hours to guide, assist, offer consultative services etc., and thus help parents, students, colleagues and others interested in education in an appropriate manner.

1.13.3. Place of Teachers in Education

It is needless to say that teachers play a pivotal role in effecting desirable changes in the life of man. Our democratic principles can be achieved only if the citizens are educated. In education children to be good citizens teachers are best agents.
The quality of the younger generation depends on the teacher, ability of the most vital links in education. On the teacher depends, to a very considerable extent, the success of any educational programme. Teachers, are in fact, the very nucleus of all educational programme. On the teacher rests the future of the younger generation. The importance of teachers has been well recognized in the past independent India, and due attention is given to teachers in the educational planning.

If the country’s education is geared to lead the young into higher planes, teachers should function as perennial springs of true knowledge. Though teachers work with boys and girls in schools they have opportunities to share significantly in shaping our whole social structure and the kind of society we will have in the future.

1.14. SCIENCE AT THE HIGHER SECONDARY LEVEL

Higher secondary level science should be introduced as separate disciplines which emphasis on experiments/technology and problem solving. The current two streams, academic and vocational, being pursued as per NPE 1986 may require a fresh look in the present scenario. Students may be given the option to choose the subjects of their interest freely, though it may not be feasible to offer all the different subjects in every school. The curriculum load should be rationalized to avoid the steep gradient between secondary and higher secondary syllabi. At this stage, core topics in a discipline, should be carefully identified. The tendency to cover a large number of topics of the discipline superficially should be avoided. Looking at the complex scenario of science education in India, three issues stand out unmistakably. First, science education is still far from achieving the goal of equity enshrined in our constitution. Second, science education, even at its best, develops competence but
does not encourage inventiveness and creativity. Third, the overpowering examination system is basic to most, if not all, the fundamental problems of science education.

1.15. LEARNING IN SCIENCE

Till two decades ago most teachers accepted a transmission model is appropriate for teaching science because they viewed science in a traditional manner; that is, they believed that science provided right answers and that truths in science are discovered (Carr, et al., 1994). The transmission model of teaching in science is deeply rooted in our culture.

Learning in science is typically a difficult task for students and this is unlikely to change because of the complex structure of science (Duit, 1991). Instead of reading or discovering the book of Nature, scientists impose constructs and concepts on observed natural phenomena to organize and to understand them better (Driver, Asoko, Leach, Mortimer and Scott, 1994). Driver et al. argue that the complexity in science lies in the study of the constructs advanced to explain natural phenomena rather than of the phenomena themselves.

On the other hand, the constructivist view of learning, has been recently developed, it has attempted to enhance innovation in science as well as university Physics teaching (Chang, 2005). In this context, to promote learning and teaching in Physics, various instructional interventions were suggested. One of them is strategy-based instruction.
As Weinstein and Mayer have put it, whereas some psychologists label problem-solving strategies as cognitive or learning strategies, some others name them as metacognitive or self-regulation strategies (Morse & Morse, 1995). In this study, problem-solving strategies, a matter of crucial importance in Physics learning, have been considered within learning strategies. Although the study of learning strategies is not a new subject in Physics, this study will definitely contribute to existing literature on learning Physics as its focus is on the effects of learning strategies on students’ satisfaction when learning Physics.

Student-learning in science is a very complex process partly because of the abstract Nature of many scientific concepts and their representation in Mathematical terms. During the last two decades the model of learning in science education literature has evolved beyond viewing students as passive receivers of knowledge transmitted by teachers.

1.16. PHYSICS EDUCATION

Physics Education is the learning, understanding and teaching of Physics and the application of Physics knowledge. There are a broad range of research interests that include the role of Mathematics and its reflection in Physics learning, the organization and deployment of Physics knowledge by experts and novices, differences in perception of physical diagrams and motion between experts and novices, transfer-studies, the design and implementation of web-based instruction, curriculum-reform, and the evaluation of educational assessments. Experimental techniques and analyses usually used in research include eye-tracking, video analysis, student interviews, web-based log-data analysis, and exam-questions
analysis. Curriculum reform and the introductory sequencing, the on-going development of web-based instructional materials etc., are other areas of interests.

1.17 USE OF PHYSICS IN EVERY DAY LIFE

Physics is an integral part of modern life. It helps us to explore answers for many issues. Whether one wants to know about the logic behind the lightning effect or understand the concept of energy conversion from one form to Physics can be provided all logical answers to satisfy and curiosity.

Heckler et al. (Heckler 2010) investigated concept learning in an introductory Physics course at the university level. Data were collected from more than 1600 students. Every few days or every week, 12 students (on the average) were asked to solve a set of multiple-choice questions based on concepts in Physics. Students were asked before, while and after the topic was taught. The proportion of correct answers was then plotted against time. It turned out that the most effective learning event was the homework activity since the homework is done with in the due time.

The goal of this work is to construct a model, which would be able to stimulate the time course of concept learning. The model presented is based on previous work done by Lei Bao (Bao 2008). The major difference is that the present model consists of two variables, one for the concept and one for the misconception. It distinguishes between not knowing the concept and the level of misconception. The differential equation system presented stimulates concept learning by positing two stable fixed points, a concept fixed point and a misconception fixed point.
Learning of concepts helps learners, to move away from the misconception fixed point so that it relaxes on the concept fixed point after the learning phase.

An initial unlearning of misconceptions is necessary to settle concept knowledge in the long run.

1.18. PLACE OF PHYSICS IN SCHOOL CURRICULUM

Today Physics holds an important place in schools. It has its disciplinary values. It also develops those qualities which can be developed by other subjects. Napoleon remarked that “The progress and improvement of Physics is linked to the prosperity of the state.”

The Kothari Commission (1964-66) suggested that “Science and Physics should be taught on a compulsory basis to all pupils as a part of general education during the first ten years of schooling.”

All great educationists like Herbert and Pestolozzi have accepted Physics as a symbol of human development. Accepting Physics as the best means of intellectual and cultural development these educationists place Physics on the top of the curriculum. There are some reasons for making Physics a compulsory subject in schools. These are as follows,

- If Physics is not given an important place in the curriculum then students would not get any opportunity for mental training and in the absence of which their intellectual development might be affected.
- For gaining knowledge of Physics no innate power is required, which is different from the ability of studying in other subjects.
Reasoning, thinking, discipline and self-confidence are developed in students by learning Physics.

Through Physics the child learns to gain knowledge systematically.

Physics is needed for studying almost all the subjects because it inculcates certain habits of thinking and reasoning.

1.19 AIMS OF TEACHING PHYSICS

Utilitarian Aim

Physics is taught primarily for its practical values and aims. The student will be given the mathematical knowledge and skills needed in his day-to-day life and enabled to make use of that knowledge and skill. This aim makes the study of Physics functional and purposeful and establishes a relation between the subject and practical life.

Disciplinary Aim

The subject is also taught for its disciplinary and intellectual values. It aims to provide training to the mind of the learner and developing his intellectual powers.

Cultural Aim

This aim helps the learner to understand the contribution of Physics in the development of civilisation and culture. It enables him to understand the role of Physics in Fine Arts and in beautifying human life.

Adjustment Aim

The learner is enabled to develop a healthy, purposeful, productive, exploratory and controlling interest in the environment and adjustment with it.
Social Aim

The learner is enabled to imbibe essential social virtues.

Moral Aim

It enables the learners to imbibe moral values.

Aesthetic Aim

The aim is to develop the aesthetic sensibilities of learners, meet their varying interests and help them in the proper utilization of their leisure time.

Vocational Aim

It is to prepare learners for technical and other vocations where Physics is applied.

Inter-disciplinary Aim

Learners are enabled to gain insights into the applications of Physics in other subjects.

Educational Preparation Aim

The goal is to prepare them for higher education in sciences, engineering and technology.

1.20. OBJECTIVES OF TEACHING PHYSICS

Physics is a science course concerned with the properties of matter and energy. This branch of science focuses on heat, mechanics, radiation, sound, magnetism and the structure of the atom. Though high school curricula are different in terms of how and what teachers teach in the Physics' classroom, there are objectives that each high school student will reach by the study.
• **Knowledge Objectives**
  He understands the inter relationship of mathematical facts, formulae, principles and processes.

• **Understanding Objectives**
  He understands the theoretical and abstract aspects of Physics.

• **Application Objectives**
  He learns the application of Physics in his day-to-day, social, vocational, occupational and recreational life.

• **Skill Objectives**
  He develops skill in solving the same problems by various possible methods.

• **Attitude Objectives**
  He gains confidence and competence in the learning of Physics.

• **Interest Objectives**
  He enjoys solving Mathematical problems of every type.

With these objectives, the subject of Physics is included in the curriculum.

**1.21. CONCEPT – MEANING**

‘Concept’ has been variously defined by sources. Philosophers generally agree that a concept is an idea formed from inference- ‘Concept’ as a conception, construct. John Locke’s description of a general idea corresponds to the description of a concept.
According to Locke, a general idea is created by abstracting, drawing away or removing the uncommon characteristic or characteristics from several particular ideas. The remaining common characteristic is that which is similar to all of the different individuals.

For example, the abstract general idea or concept that is designated by the word “red” is that characteristic which is common to apples, cherries, and blood. The abstract general idea or concept that is signified by the word “dog” is the collection of those characteristics which are common to Airedales, collies.

Philosopher Arthur Schopenhauer argued that concepts are “an abstraction from what is known through infinitive perception and they have arisen from our arbitrary thinking away or dropping of some qualities and retention of others.”

Nietzsche who was heavily influenced by Schopenhauer wrote, “Every concept ignites through our equating what is unequal. No leaf ever wholly equals another, and the concept “leaf” is formed through an arbitrary abstraction from these individual differences, through forgetting the distinctions.

Immanuel Kant held that the account of the concept as an abstraction of experience is only partly correct. He called those concepts that result from abstraction “a poster ion”.’Concept’ is a general representation or non-specific thought-of that which is common to several specific perceived objects. A concept is a common feature or characteristic. Kant investigated the way that empirical posterior concepts are created. The logical acts of the understanding by which concepts are generated are:
a) Comparison is the linking of mental images to one another in relation to
the unity of consciousness.
b) Reflection is the going back over different mental images how they can
be comprehended is consciousness and
c) Finally abstraction or the segregation of everything else by which the
mental images differ.

According to Laurelte Taylor says “Acting is the physical representation of a mental
picture and the projection of an emotional concept.

1.22. COGNITIVE LOAD THEORY AND INSTRUCTIONAL THEORY

Cognitive Load Theory (CLT) originated in the 1980’s and underwent
substantial development and expansion in the 1990’s. It is a major theory providing
a framework for investigations into cognitive processes and instructional design.
CLT states that the brain can only handle a limited amount of new information at a
time. It was developed by the English researcher John Sweller in the 1980’s during
his work with students and problem – solving experiments.

It is now widely-used, as a research-based set of principles used to design
more efficient instructional strategies. The theory has its roots in the study of
memory. All human learning uses two memory types- working memory, and long-
term memory. Working memory is the active component; its main role is conscious
processing, while long-term memory is the main knowledge repository. Working
memory has very little storage capacity, and is easily overloaded if too many pieces
of information are brought in at a time.
Although the information that learners must process varies on many dimensions, the extent to which elements interact is a critical feature. Information varies on a continuum from low to high interactivity. Each element of a low-element interactivity material can be understood and learned individually without consideration of any other elements. The elements of high element interactivity materials can be learned individually, but they cannot be understood until all of the elements and their interactions are processed simultaneously. As a consequence, high-element interactivity material is difficult to understand.

Element interactivity is the driver of our first category of cognitive load. That category is called “intrinsic cognitive load” because demands on working memory capacity imposed by element interactivity are intrinsic to the material being learned. Different materials differ in their levels of element interactivity and thus intrinsic cognitive load, and they cannot be altered by instructional manipulations; only a simpler learning task that omits some interacting elements can be chosen to reduce this type of load. The omission of essential, interacting elements will compromise sophisticated understanding but may be unavoidable with very complex, high element interactivity tasks. Subsequent additions of omitted elements will promote understanding. Simultaneous processing of all essential elements must occur eventually, despite the high-intrinsic cognitive load because it is only then that understanding commences.

Working memory, in which all conscious cognitive processing occurs, can handle only a very limited number possibly no more than two or three – of novel interacting elements. This number is far below the number of interacting elements that occur in most substantive areas of human intellectual activity. Alone, working
memory would only permit relatively trivial human cognitive activities. Long-term memory provides humans with the ability to expand this processing ability. This memory store can contain vast numbers of “schemas” - cognitive constructs that incorporate multiple elements of information into a single element with a specific function. Schemas can be brought from long-term to working memory, whereas working memory might, for example, only deal with one element that may consist of a large number of lower level interacting elements. Those interacting elements may far exceed working memory capacity if each element had to be processed. Their incorporation in a schema means that only one element needs be processed.

CLT is concerned with the instructional implications of this interaction between information structures and cognitive architecture. As well as element interactivity, the manner in which information is presented to learners and the learning activities required of learners can also impose a cognitive load. When that load is unnecessary and interferes with schema acquisition and automation, it is referred to as an extraneous or ineffective cognitive load. Extraneous cognitive load is a second category of cognitive load. Many conventional instructional procedures impose extraneous cognitive load because most instructional procedures were developed without any consideration or knowledge of the structure of information or cognitive architecture. Any instructional procedure that requires learners to engage in either a search for a problem solution or a search for referents in an explanation is likely to impose a heavy extraneous cognitive load because working memory resources must be used for activities that are irrelevant to schema- acquisition and automation.
Extraneous cognitive load is primarily important when intrinsic cognitive load is high because the two forms of cognitive load are additive. Instructional designs intended to reduce cognitive load are primarily effective when element interactivity is high. When element interactivity is low, designs intended to reduce the load on working memory have little or no effect.

The last form of cognitive load is germane or effective cognitive load. Like extraneous cognitive load and unlike intrinsic cognitive load, germane cognitive load is influenced by the instructional designer. The manner in which information is presented to learners and the learning activities required of learners are factors relevant to levels of germane cognitive load.

1.23. PROBLEMS IN CONCEPT LEARNING

Many concepts pose a challenge to learn, and are learned slowly as more examples and rules are integrated and information is sorted into more straightforward units. Students learn concepts as different rates, and a student who demonstrates mastery of one concept very quickly may find another particularly challenging. However, same students have more than the expected amount of difficulty in learning concepts.

Students with learning disabilities often have an especially difficult time learning concepts. Although the degree of difficulty and the types of concepts that commonly present problems differ depending on the learning disability, the degree of disability among children with the same problems is common. Bank/Math concepts, time concepts, including time sequencing, and reading concepts are likely to present significant challenges. Students with such problems in learning concepts
may benefit from additional educational strategies to help prevent the student from falling behind, as additional information and concepts are built upon concepts that were not completely mastered.

Children and adolescents often bring a lot of information into the classroom. Unfortunately, information gathered through life and experiences outside the classroom is not always completely accurate. Many children have previously conceived notions of concepts before being exposed to them in a classroom setting. Mastering a concept in the classroom involves conceptual change—that is, replacing a previously held concept with a new one—student can encounter unexpected difficulties. It is important to identify situations in which previously held concepts are at conflict with the concept being taught, because different educational strategies have to be applied.

Much of the literature about the difficulties encountered in conceptual change has involved the sciences. This is because students often have ideas about natural phenomena, such as what causes rain, and why it is dark at night, before learning about them in school. In these situations educator led investigation and discussion may not be the most effective road to concept learning.

This is because it may be difficult for students who believe that they understand something to think outside that understanding or to accept different ideas presented by other students.

In this case, teacher-provided rules and critical criteria can help a student overcome a previously believed, but incorrect concept. Teaching conceptual change can also be accomplished by discussing student preconceptions about a concept,
discussing evidence contrary to the preconceived concept, and guiding the student through a changing understanding to a mastery of the correct concept.

1.24. LEARNING CONCEPTS IN PHYSICS

Physics is the scientific and detailed study of matter and energy change and their interaction in this world. Their interaction results in different kinds of energy and takes the form of motion, light, electricity, radiation, gravity and almost everything else. The subject deals with matter on scales ranging from sub-atomic particles to stars and even entire galaxies.

In another way, Physics can be better defined as an organized way of interacting with Nature. The subject logically enables physicists to seek logical answers from Nature. The answers obtained from Nature help us to understand the working of the world and impart new knowledge and learning about our mysterious universe.

The basic idea of Physics is present in other branches of science including Astronomy, Biology, Chemistry and Geology. In fact, Physics is an indispensable element of applied science and engineering which has generated results such as supersonic jets, laser technology, and latest computer systems to ultra-modern equipments to add luxury to our normal lives. As a result, Physics is a fresh and exciting learning subject.

The subject matter of Physics takes inspiration from experiments on the basis of assumed hypothesis through a well-defined scientific method, based on the observation of the world. In addition, the results of experimentation can further be utilized in generating other scientific laws and predicting other phenomena.
However, it is important to have a good knowledge of Mathematics for understanding the concepts of Physics.

1.25. ABSTRACT CONCEPTS IN PHYSICS

An abstract concept is an idea that is not related to any specific instance or object. It can be potentially applied to many different situations or objects. People with cognitive deficits often have problems in understanding the abstract nouns are words for things that can’t be experienced by any of the five senses; they can’t be seen, heard, smelled, tasted or touched. Some examples are: love, freedom, honesty, anger etc. Another set of links is to what we call more “abstract” concepts and more “concrete”. An abstract concept is a concept which does not have a direct realization of object.

1.26. SELECTED INSTRUCTIONAL APPROACHES IN TEACHING ABSTRACT CONCEPTS IN PHYSICS

When the teacher has to complete the syllabus within the stipulated time, he/she is compelled to resort to the lecture method. The lecture method is a pedagogical tool which cannot be substituted; it is a strong teaching tool when used properly. But there is a tendency of over using it in the classroom. This trend is seen especially in the classrooms of our country. In the sub-continent of India, science teaching in schools is primarily oral. The teacher recites the book knowledge. There is virtually no practical work, and the teacher is mainly concerned with “finishing” the prescribed textbook, and preparing students for government examinations. Schools are competing with each other to declare excellent results and high passing percentages. According to Patkar, (Education Times, Feb: 7, 2006) this makes one
wonder “whether the schools are factories churning out students as products” with no meaningful learning.

This is partly because of the large student enrollment in classes (Devi, 1999), and students aspiring to get good marks to compete for admissions in engineering and medical colleges (Kapur, 2002; Khattar, Education Times, 2008). Students, therefore, hardly make meaningful connections between their personal ideas and the subject learnt. This leads to a “clutter of ideas,” which students cannot use in open-ended problem solving situations (Rao, 2003). The present scenario is seen from the sixties. Bharambe (1997) quotes, The Report of the Education Commission (1964-66) that “In the average school today, instruction still conforms to a mechanical routine, continues to be dominated by the old besetting evil of verbatim reproduction and therefore remains as dull and uninspiring as before”. She also mentioned in her study that many students, due to lack of attention and participation, refrain from understanding the patterns of logical organization and they do not apply their mind to discussion.

The researcher had schooling in the traditional set up and had been a teacher in a school for more than 30 years. It was always the researcher’s passion to explore new ways of teaching so that learning becomes effective and moves away from the dull monotony of traditional methods. Furthermore, the researcher could feel in the changed scenario, with many newer stimuli, through various media all around, students require innovative science methods to apply their mind, in the analyzing and understanding of the natural phenomena around them.
1.27. NEED AND SIGNIFICANCE OF THE STUDY

In a rapidly developing country like India which is surging fast in the new millennium, the whole system of education revolves round academic achievement, though various other outcomes are also expected from the system. Thus a lot of time and effort of the schools are used to help students to achieve better in their scholastic endeavors. In spite of this, our students score low marks in various subjects but this shortfall in achievement is high in Physics. Even though many attempts have been made to improve the level of attainment there seems to exist mainly three categories of students as high- average- and low achievers.

The importance of achievement has raised several questions for the psychological factors that promote achievement in students. The variables contributing to the educational achievement are to be identified. A review of the previous studies reveals that there are various strategies to promote numerical reasoning, ability to use symbols, abstract reasoning, inductive reasoning, deductive reasoning, problem solving ability, creativity, self-concept, achievement, motivation etc., which can be tried to promote achievement in Physics.

The effectiveness of the selected strategies will enhance the understanding of any abstract concept in any branch of science. Researchers have attempted to deal with all kinds of approaches and in particular have selected the instructional approach as the suitable means to enhance the understanding of the abstract concepts in Physics by higher secondary students. They have traced the growth of methods of teaching since the ancient days and listed the shortfalls of the traditional passive method of learning and the advantage of the present mode of teaching through the instructional approach.
1.28. STATEMENT OF THE PROBLEM

International competition has fuelled the flame of educational reforms in different countries. One of the core issues in on-going educational reforms is the development of a highly qualified, skilled and committed teaching force for educating all students from diverse backgrounds with a view to prepare them to meet the challenges in future. The National Policy on Education (1986) proposed the need for modifying curriculum and methodologies of learning through appropriate research and enhancing attention-activation techniques. Innovative technologies have provided a new dimension in teaching and learning. The present study has been undertaken with a view to promote understanding of abstract concepts in Physics among higher secondary students. The problem for the present study is based on the issue of “Effectiveness of Selected Instructional Approaches to Enhance Understanding of Abstract Concepts in Physics among Higher Secondary Students”.

1.29. SCOPE OF THE STUDY

In order to bring any significant change in the teaching of Physics there is a need to expose teachers to various strategies which will result in better teaching and learning. For success, teachers have to be provided with materials which are different and more effective than those traditionally presented in the text books and also exposed to individualized instructional strategies.
New methods and techniques in education are increasingly making an impact on the conventional approach in teaching and learning. The Instructional approach is a well-known method which involves better and effective teaching and learning. It helps the teacher in covering more content in less time in a more effective way.

In science, many studies have already been conducted to prove the effectiveness of instructional approaches as compared to other methods of teaching. In Physics, such studies are confined to the effectiveness of the instructional approach in linear style as compared to traditional methods of teaching. Attempts are to be made to establish the effectiveness of teaching Physics through instructional approach as against conventional methods of teaching. In Physics, there are topics like Atomic Physics, Nuclear Physics and Units and Measurement which are difficult to be taught by instructional approaches due to the complexity of the content. They will demand a large number of frames to cover the content. The present study seeks to establish the effectiveness of selected Instructional Approaches in enhancing understanding of abstract concepts in physics among higher secondary students.

1.30. CONCLUSION

Learning is a process in which students interact with the teachers and get learning experience. Learning experience is nothing but the enhancement of knowledge in a specific field. If students face any problem or difficulty, naturally the knowledge enrichment process will be affected. It is the duty of the teacher to provide enough learning experiences through the teaching-learning process. If the teaching-learning process is hindered a review of the strategies is warranted.
Students should get knowledge up to the expectancy level. The investigator made an attempt in this direction to identify the difficulties and problems of students in learning physics at the higher secondary level and possible strategies to promote understanding of basic concepts and through gradation abstract concepts in Physics.