1.1. Concept, Meaning and Definition of Human Resource Development

It is a well-known fact that the economic growth as well as national development of a country is decisively determined by the resources available in that country. There are various resources such as water resource, land resource, mineral resource etc., which all serve as vital determinants of a country's economic growth and ultimate development.

The fundamental factors that promote the national development and economic growth are non-economic and non-materialistic in character. It is the spirit itself that builds the body. Some countries of the world have experienced a rapid rise in income and living standards to a very great extent while other countries continue to stagnate at the lowest rung of the ladder and wallow in poverty and penury. The spirit has been the primary guiding factor of national development in all the developed countries.
The size and quality of the people, the size and efficiency of the labour force and the serving cadres, the health, intelligence and diligence of the people the sense of discipline, character and the spirit of cooperation of the people etc., are certain factors that facilitate national development.

But, these are obviously the outcomes or the resultant products of human resource development. Though there exist various resources such as water resource, land resource, forest resource, energy resource, human resource etc, which all serve as vital determinants of a country's ultimate development, the resource that decisively determines the economic growth and national development of a country is invariably the human resource. Without developed human resource, nothing remarkable can be achieved.

Most of the backward countries are backward not because they lack physical and financial resources but because they are confronted with acute shortage of skilled personnel and technicians. Education encourages, promotes and develops openness of mind, tolerance, cooperation and ability to adjust to the changes, which are the marked characteristics of developed human resource. Above all, it lays stress on the qualities of courage, confidence, perseverance and endurance and encourages a vigorous and relentless pursuit of truth and free enquiry that provide the cutting edge required for a performance par excellence. Education enhances the understanding of the behaviour of interrelationships among the tangible and the intangible phenomena surrounding and imparts the required skill to translate the knowledge into action and to make the most beneficial use of them. These developments in the human resources which may be termed as human capital, contribute much more to economic growth and national development than physical capital (Ghosh, 1996). Effective use of all resources available in a particular country largely depends upon the degree of human resource development attained in that country.
Quality as well as efficiency of population depends upon its education, health, vigour, training, morale etc., Provision of better education, medical facilities and training opportunities etc., are tantamount to investment in human capital, as distinguished from investment in material capital like machines, tools etc., It has been estimated that the return, in terms of output, has been as high or even higher from human capital than from an equal investment in real capital. Investment on human capital will ensure multifold return more than from the investment in real capital. It is the spirit that is more important than the matter. And it is the brain that is more vital than brawn. This conclusion is becoming increasingly valid with the advancement of technology and sophistication in products. The educated, experienced and efficient personnel are necessary to manage the complex economic life of growing economies and adequately trained & technical, alert and active labour force is necessary to man the complicated machines.

A natural resource is anything found by man in his natural environment. He can, in some way or the other, utilise it for his own benefit. On the other hand, human resources are the human beings whose contribution the society can use for different purposes. The worker in a factory is an example of a human resource. Human resource refers to the various service cadres. Human resource is the wealth and treasure of a prospering and progressing country. Here, every one is unique in his own sphere and his contribution cannot be ignored. Farmers, carpenters, cobblers, plumbers, masons, potters, government servants etc, are the indispensable as well as integral constituents of human resources.

Human resource development refers to the qualitative improvement of the labour forces and the service cadres by way of providing better education, proper training and ensuring good health which will, ultimately, tell upon their performance. Human resource development ensures refinement, precision, speed and accuracy in planning and execution. It can be said that human resource development means preparing individuals so as to make them evince utmost manifestation and efficient
application of potentials in the task assigned or undertaken. Where there is a good degree of human resource development, there will be invariably an all-round development for it is the human resource development that gears up the national development.

1.2. Education – A Prerequisite for Human Resource Development

A country’s national development as well as economic growth is decisively determined by the degree of human resource development attained in that particular country. The human resource development is very much influenced by the degree of excellence in education. A rigorous type of education ensures mastery learning, a perfect application of the knowledge acquired and a better dissemination of new concepts for wider application. Excellence in education can be noticed as an underlying factor in the development of all the advanced nations. It is the key to advancement in science and technology, which can gear up national development to a very great visible extent.

It may be observed from the fact that some nations, though they have all sorts of material resources, could not become a completely developed country just because they do not have a higher order of human resource development. Such nations are not able to derive optimum benefits out of their material resources. The lion’s share goes to the nation that provides the technical know-how to them. Such nations, in spite of their material resources, are still developing because their human resource is not adequately developed. An effective utilisation of material resources like mineral resource, water resource, oil resource etc. largely depends on the degree of human resource development attained in that particular country. The nations that draw students from other nations for higher education are highly developed because of the excellence in education available in those nations.

Excellence in education is a pre-requisite for better expertise, talent and skill. A higher degree of learning can be ensured only by an excellent educational system. There can be no excellent educational system without
advancement in science and technology. A country’s development as well as its economic growth is decisively determined by the advancement made in the field of science and technology. This envisages the need and importance of science education.

1.3. Role of Higher Secondary Education in Human Resource Development

The role of higher secondary education is of paramount importance in human resource development. It is vital and pivotal, since it is a stepping stone for higher education. It is the bridge between the school education and collegiate education. It serves as foundation block for higher education. This is the stage during which preparation is made for higher order of human resource development. This stage is noted for aspiration as well as inspiration and perspiration. In a sense, the higher secondary stage is the touchstone of human resource development. It makes the beginning paving way for greater efforts.

Without higher secondary education, optimum human resource development cannot be brought about with only school education. Higher secondary education is the turning and pivotal point in the career of the students. A good clerical cadre or a task force or low order technicians can be made without higher secondary education. It marks minimum level of the human resource development. This level of human resource development will not be sufficient to ensure optimum national development for which mentally potential professionals are required. A higher order of human resource development alone can ensure a marked progress in the field of science and technology which will, in turn, promote the economic growth of the country. The first branching out in education takes place at higher secondary level. Each of these branches provides different personnel and professionals required for the various administrative tentacles of a nation. If the higher secondary education is not strengthened and if it is not given much importance, many students will cease at the high school level and there will be a very thin input for higher education which plays a pivotal role in igniting the spark of national
development. Only a higher order of education can promote marked human resource development and rapid national development. It reveals that education serves as foundation block for human resource development.

1.4. Science Education: Concept Meaning and Significance

Science plays a significant role in our daily life. A man without contact with science and its manifestations will be a complete misfit in the modern society. Science is one of those human activities that man has created, to gratify certain desires and human needs. Science is the most inexhaustible storehouse of knowledge. It offers the widest range of knowledge to the learners. There is infinite scope for broadening one’s horizon of knowledge. The learner wonders at the intricacies and mysteries of nature, the known and the unknown. These tend to create a broader outlook in the mind of the learners.

A few decades back, science was given a step-motherly treatment and was considered to be a subject meant for less promising students. The more promising ones were encouraged to study the classics and mathematics as being more worthy and suitable subjects. Science has now established its claim to be placed in the school curriculum. Science education occupies a very eminent place in curriculum both at school and university stages of education. Continuous advances in scientific and technological research has led to the growth and greater application of science in the contemporary society. Accordingly science has become a priority area in education both at the compulsory education level as well as at the level of specialisation. It has taken good many years of active and persistent effort to reach this position.

The reasons for the inclusion of science in the curriculum are exactly the same as those for the inclusion of other subjects. All school subjects are taught because they provide a liberal education. They are part of the equipment and preparation for life, which we expect the school to give to its pupils, so that they may play their part in the community as intellectual
citizens in present and future. Science takes its place side by side with other subjects as an essential element of one’s education. It affords knowledge of certain facts and laws and an insight into methods and data peculiar and pertinent to the domain of science. However, the inclusion of any subject in the curriculum should satisfy the intellectual, utilitarian, moral, vocational cultural and aesthetic values. This is also true in case of science education. Thus science education, if properly conceived should, primarily be concerned with the education of the mind rather than acquisition of isolated pieces of scientific knowledge.

**Different Branches of Science**

There are different branches of science study. They can be divided into four major groups.

1) Mathematics and Logic

2) The Physical Sciences

3) The Life Sciences, and

4) The Social Sciences

As scientific knowledge has grown and become increasingly complicated, many new fields of study have emerged. At the same time, the boundaries between scientific fields have become less and less clear cut. Numerous areas of science overlap and it is often hard to tell where one science ends and another begins. For instance, both physics and chemistry deal with atomic structure. In some cases, science subjects have come to overlap so much that interdisciplinary fields have been established. Such fields combine parts of two or more sciences.

The physical science examines the nature of the universe. They study the structure and properties of non-living matter from tiny atoms to vast galaxies. The physical sciences include

1) Astronomy

2) Chemistry

3) Geology
4) Meteorology
5) Physics

Physics is the study of energy and matter and the relationship between them. Studying physics, like studying all sciences, is a way of solving problems and discovering why things happen the way they do. It seems that we have always tried to explain the world around us. Science began and continues due to our curiosity, and our curiosity often leads to new discoveries. The laser, for example, is a result of curious physicists wanting to know more about light. These scientists had no special purpose for the laser; they were simply investigating ways to produce powerful light beams.

Physics is concerned with matter and energy. Physicists study mechanics, heat, light, sound, electricity, magnetism and the properties of matter. Atomic physics involves the study of the structure and properties of atoms, and nuclear physics focusses on the make up and behaviour of the nuclei of atoms. Particle physics deals with nature of electrons, protons, mesons and other tiny bits of matter smaller than atomic nuclei. Cryogenics examines the behaviour of matter at extremely low temperatures and plasma physics investigates the behaviour of ionised gases at exceptionally high temperatures. Solid state physics studies the properties of extremely pure crystals and other solid materials.

1.5. Objectives and Importance of Teaching Physics

National Science Teaching Association, Washington (1961) gives the following objectives of physics teaching.

1) A basic knowledge of nature of the scientific enterprise
2) An increase in the mathematical observational and experimental skills.
3) Understanding related to the inter relations of physics and society
4) Increased understanding of concepts and theories, which describe to unify the fields of science.
Physics is the science devoted to the study of matter and energy. Physicists try to understand what matter is and what it does. They seek to learn how energy is produced, how it travels from place to place, and how it can be controlled. They are also interested in how matter and energy are related to each other and how they affect each other over time and through space. Physics means natural things.

Physics deals with the materials, the universe beyond the earth’s atmospheres. It covers the entire spectrum of scientific knowledge. A primary concern of the major physics curriculum projects is to communicate that physics is more than a collection of facts and static concepts and laws. It is a growing dynamic network of evolving models and conceptual schemes.

The destiny of a nation is being shaped in her classrooms. The science content should be chosen on the basis of its possible contribution to the objectives. Content of the course should bear direct significance to life’s problems and activities. The activities should include abundant opportunities to apply acquired knowledge, skill and attitude in various life situations.

Physics encourages certain attitudes and carries a specific information content. Physics requires a methodical study possible to choose simple system. It illustrates the cumulative character of scientific thought showing how a new concept emerges from the old. Physics enables man to control and exploit forces and resources of nature to elicit more about the meaning of purpose of life. It is physics that determines to a large extent the foundation of an outlook, as well as the possibilities and limits of our practical values. One cannot be called a specialist or an educated person, unless one is familiar with certain range of ideas and facts in the sphere of physics.

Physics lies at the heart of sciences. The progress of physics determines the possibilities of development in a wide range of sciences. Physics is taught because.
1) It promotes an imaginative, creative and abstract thought.
2) It helps to adopt good study habits.
3) It helps pupils to interpret experimental results.
4) It makes the pupil think critically about one’s own speciality.
5) The students of physics are able to handle new experiments and new experimental techniques.
6) It helps to acquire mathematical skills.
7) It provides training to write technical report and scientific papers.
8) It helps to apply learned problem solving techniques to unfamiliar situation.
9) It helps them with knowledge of where to find and when to apply certain pieces of information without memorising.
10) It helps them make a career in physics.

In general, physics teaching can be reduced to two global goals.

1) Providing experiences that will enable some students to reach the frontiers of physics and the other natural sciences to make scientific and technological contributions in their own right.

2) Providing a foundation of general understanding and reasoning for students who will not specialise in sciences that will be sufficient for enlightened citizenship in a technological age.

1.6. **Methods of Teaching Science**

Method is a recognised way of teaching a subject or a lesson. It may be lecture, seminar, demonstration, discussion, or workshop. Tactics are specific ways of implementing a particular method in a particular case. The sets of methods to be adopted in sequence provide the instructional plan. The same method may have to be implemented using different facts in different contexts with reference to specific teaching learning problems. When a method is found effective in a specific context whether self instruction or group instruction, that method is recommended for the whole curriculum. But ‘either-or’ approach to the selection of instructional methods will not prove effective under all circumstances. The question, then, is not whether to use group or individual study methods, but teachers
need to know when to use which. What is required for an instructional designer is the ability to make an effective mix of group structures considering the practical and educational considerations.

Approaches to teaching science can be classified into two types as

i) Teacher centred method

ii) Pupil centred method

i) Teacher Centred Method

The following are the teacher centred methods. They are

i) Lecture Method

ii) Lecture cum Demonstration Method

iii) Historical Method

In the above methods, teaching is only exposition type in which the focus is on telling, memorisation and recalling information. These are all large group methods being performed universally. Very often teaching is a monologue, a continuous oral and formal exposition of some topic. It is an instructional technique of an oral discourse on a particular subject. In the lecture demonstration type the lecture is used as a prelude to a demonstration. After the demonstration, the main points are summed up in short final lecture. In all the above methods, the students are just passive recipients of knowledge. The participants’ role is restricted to only asking and answering questions on which the teacher has taught. The teaching environment is very much formalised and the teacher occupies a central position in the classroom.

ii) Pupil Centred Methods

There are some pupil-centred methods to teach science. The important pupil centred methods are:

i) Heuristic Method

ii) Assignment Method
iii) Project Method

iv) Discussion Method

In pupil centred teaching method, the whole teaching learning process is geared to the needs, requirements, capabilities and interest of the pupils. The purpose is to develop in the learners skills and abilities in independent learning and problem solving. The classroom climate is flexible and psychologically open. The students and teachers jointly explore aspects of the problems rather than teach, telling the students about the solution of the problem. The teacher’s role is to create conditions from which a problem may develop, have materials and resources available to the students and help them identify issues, state hypotheses, clarify and test hypotheses and draw conclusions. This warrants introduction of innovative strategies in teaching learning process.

1.7. Need for Innovative Methods in Teaching Physics

Teaching effectively is the most important of all the competencies required of a successful teacher. Since effective teaching deals with the needs, interest and abilities of pupils and individuals, it requires knowledge of the environment in which the pupil lives, the development problem he or she faces and his/her mental abilities. It is more true so when the teacher is dealing with the backward students. It also calls for an understanding of the learning processes essential for creating an environment where learning can take place and for making instruction so stimulating that every pupil will be motivated to learn. Stimulating pupils to think critically, independently and creatively is essential for effective teaching.

Effective teaching in any subject depends largely upon the introduction of newer methods of instruction. There is a growing need for trying out newer methods of instruction and establishing their effectiveness in teaching. Now-a-days a teacher cannot depend on any single method of teaching. The teacher has to try out several innovative methods to present the content to the students. When they are taught by innovative methods,
the students are able to understand the concept, principles and content in an effective manner.

The immense knowledge explosion taking place in the world warrants newer method of teaching. Students need unique experience in the presentation of the content. Moreover, the advent of educational technology has led to emergence of new innovative methods like video instruction, computerised instruction, programmed instruction, modular instruction etc. These methods make use of instructional technology profusely in their approach and applications. Now a successful teacher has to employ an appropriate instructional technology in teaching learning process to achieve best the pre-determined behavioural objectives.

1.8. Concept of Educational Technology and Instructional Technology

The development of a modern educational technology has been either heralded as the necessary ingredient of an educational revolution which will lift the schools out of the Dark Ages and lead them into twentieth century enlightenment or castigated as a movement which can only reduce teachers and students into robots in the manner described by our more pessimistic science fiction. The dispute often fails to distinguish between two meanings of instructional technology (Lumsdaine 1966). One meaning refers to the detailed application of the psychology of learning to practical teaching problems. Francis Mechner (1965) uses this analogy. In the same way that an aeronautical engineer believes that he can design an airplane by applying a few basic physical principles and a little art and intuition, the educational technologist believes that he can build in the student a complex repository of knowledge or behaviour by applying a few basic principles of learning psychology in addition to a little art and intuition. Arthur Melton (1959) observed that educational technology is based on the assumption that the psychology of learning encompasses all forms of relatively permanent behavioural changes which result from experience, including, of course, the experiences of child in school. The educational technologists describe how to programme materials and how
to apply the psychology of learning to practical teaching problems. In other words, they are describing educational technology in this scientific sense. The programmes which such a technology produces are often called the software to distinguish them from the machines, or hardware, into which the programmes are fed. The second meaning of educational technology refers to the application of engineering principles in the development of electromechanical equipment used for instructional purposes. Examples of these devices are motion pictures, tape recorders, teaching machines and computers—the educational hardware.

The two meanings of instructional technology interact in the design and use of equipment to provide control over the learning situation, a rich array of stimulus material and interaction between the responses of the learner and the presentation of instructional material. When we organize instruction as in the case of team teaching, modular scheduling, and instructional systems, we must combine our application of the psychology of learning with electromechanical engineering to produce the desired results. In fact, H.A. Bern (1967) suggests that the educational psychologist of the future may be a psychologist engineer.

There is a marked difference between educational technology and instructional technology. The educational technology chiefly refers to the hardware. On the other hand, the instructional technology refers to the software. Instructional strategy refers to the application of appropriate psychological principles or definite methods and techniques in the instructional process. Instructional strategy is a means of achieving the instructional objectives in the best possible manner at the lowest possible cost.

Without proper instructional strategy, it is not possible to bring about all-round human resource development. Instructional strategy should be designed in such a way that it should promote the learning of all categories of pupils i.e. above average, average and below average students. The educational philosophy, psychological theory and the appropriate educational technology and the predetermined educational objectives should be the criteria to decide upon the instructional strategies. There are
various approaches, methods, techniques and models to impart / instruct the students.

Media play a vital role in any instructional strategy. Since the present age is rightly called technological age, we can't decide upon any instructional strategy which does not involve media application. An instructional strategy, which encompasses maximum utilisation of media, can alone ensure effective teaching learning process. Though there are various components of media, in a developing country like India, video and audio instructions are found more feasible and profitable. Modular instruction, video instruction and CAI are certain instructional strategies which make use of instructional technology to the best advantage of the students.

1.9. Individual Differences in Students

The problem that plagues every teacher in every subject at every grade level is how to teach a lesson to a class that contains students with different skills and learning rates. Accommodating instruction to student differences is one of the most fundamental problems of education and often leads to politically and emotionally charged policies.

The problem of accommodating student differences is so important that many educationists have suggested that instruction be completely individualised so that students can work independently at their own rates. In the past twenty years, this point of view has led to the creation of individualised instructional programmes and computer assisted instruction. Simply speaking, individual difference refers to how the students differ from one another in a variety of ways, some important to instruction, some not.

Each of the many ways of accommodating student differences has its own benefits, but each introduces its own problems, which sometimes outweigh the benefits. Researches on various means of accommodating classroom instruction to student differences have been undertaken. However, before delving into the details, it will be apt on our part to
consider what student differences are and which of them the teachers must take into account.

Bases of Individual Differences

From their first day in a school, students differ. They differ on several obvious dimensions that are of little importance to instruction, but they also differ in cognitive abilities and learning rates, which are of great concern to educators.

Many students enter L.K.G. or first standard knowing the alphabet and numbers upto ten, and some can already read a little. Others lack these skills. As time goes on, initial differences among students tend to increase, and by high school or higher secondary school level students may enter class with markedly different skills.

Differences in prior learning create the most serious problem in instruction (Tobias 1981, Corno and Snow 1986). For example, if a teacher presents a series of lessons on the discovery of America, it is of considerable importance to know how much students already know about the subject, how much they understand about the Renaissance in Europe, how well they can interpret maps and globes, and at the most basic level, how well they can read. If students are quite diverse in these skills, then the teacher must somehow take this diversity into account when presenting the lesson.

Another student difference that teachers have to take into account is learning rate. Even if all the students begin class at same level, some are likely to learn more easily and rapidly than others. For example, a class learning a foreign language for the first time might begin with equal ignorance, but some students have an ‘Ear’ for foreign languages that others lack, and some have greater motivation to learn a foreign language than others. For these and other reasons, some students will learn more rapidly than their classmates.

A third difference that the teachers should be aware of is learning style (Dunn and Dunn 1978; Mossick 1984 and Carbo et.al., 1986). For
example, some students learn best auditorily, some visually. Some work best alone, others with peers. Some need total silence to concentrate, others work well in a noisy room. Low achievement in academic performance may be due to the aforesaid factors. The instructor should, therefore, take care of such bases of differences and accordingly devise his instruction so as to cater to the various categories of students in the classroom.

1.10. **Computer Assisted Instruction: Concept, Meaning and Definition**

Any discussion on instructional technology without highlighting the current use of computers will be incomplete. One means of individualised instruction that has been receiving a great deal of attention in recent years is computer assisted instruction or CAI.

Computer aided instruction has a rich history and developed concurrently with the development of electronic computers (Daniel, 1999). CAI began in the mid-1950s as collaboration between Stanford University and IBM but grew slowly until the arrival of personal computers in the 1980s. Today there are few schools in the United States that do not have computers available for student use, and don’t use some form of CAI on those computers.

While educational effectiveness and implementation issues have been common, CAI has remained popular among educators who maintain a belief that it is a useful supplement to classroom activities.

Computer aided instruction (CAI) encompasses a broad range of computer technologies that supplement the classroom learning environment and can dramatically increase a student’s access to information. CAI programmes, which can include directed drills, practice exercises, and communication between students and teachers, can adapt to the abilities and preferences of individual students and increase the amount of personalized instruction a student receives. Students also benefit from the immediate feedback provided by computers and most of them appreciate the self-paced learning environment. At its best, CAI
engages student interest, motivates them to learn, and increases their personal responsibility for learning.

“Computer-assisted instruction” (CAI) refers to instruction or remediation presented on a computer. Many educational computer programmes are available online and from computer stores and textbook companies. They enhance teacher instruction in several ways.

Computer programmes are interactive and can illustrate a concept through attractive animation, sound, and demonstration. They allow students to progress at their own pace and work individually or problem solve in a group. Computers provide immediate feedback, letting students know whether their answer is correct. If the answer is not correct, the programme shows students how to correctly answer the question. Computers offer a different type of activity and a change of pace from teacher-led or group instruction.

Computer-assisted instruction improves instruction for students with disabilities because students receive immediate feedback and do not continue to practise the wrong skills. Many computer programmes can move through instruction at the student’s pace and keep tract of the student’s errors and progress. Computers capture the students’ attention because the programmes are interactive and engage the students’ spirit of competitiveness to increase their scores. Also, computer-assisted instruction moves at the students’ pace and usually does not move ahead until they have mastered the skill. Programmes provide differentiated lessons to challenge students who are at risk, average, or gifted.

The computer was used in the beginning just like a teaching machine for presenting programmed instructional materials. This way of using the computer is called computer assisted instruction (CAI). In the 1960’s the computer was used in this way in some of the universities in USA. Once the instructional materials are computerised, the students can learn individually at the computer terminals. One computer can have several terminals and a large number of students can learn simultaneously from one computer. One project entitled PLATO (Programmed Logic for Automatic Teaching Operation) developed by Professor Donald Bitzer at the University of Illinois in collaboration with Central Data Corporation,
used a very large computer controlling up to 4000 terminals (Woodhouse and McDougall, 1986).

Professor Patric Suppes of Stanford University developed a number of courses for use in CAI approach including courses in foreign languages (such as Chinese and Russian). In such an approach, the computer is not just used like a teaching machine, as it is capable of doing much more than can be done by a teaching machine. For a great variety of branching techniques can be adopted in CAI programmes which cannot be done in a teaching machine. The course is broken up into small elements of information which the computer presents one by one followed by small questions. If the student gives correct answer, the computer gives further information. If he gives a wrong answer, depending on the answer, the computer gives alternate supplementary information. If the student can now give the right answer, the computer advances on the main programme and gives further information and puts questions. Here the computer is used as a tutor.

The decreasing cost and increasing availability of micro computers in schools have led researchers as well as teachers to become more interested in computer assisted instruction (Becker, 1986). The idea behind computer assisted instruction is to use the computer as a tutor to present information, give students practice, assess their level of understanding and provide additional instruction, as it can analyse student responses immediately to determine whether to spend more time on particular topic or skill. The computer can be quite effective in presenting ideas, using pictures or diagrams to reinforce concepts. Finally, for most students the computer seems to have a motivating quality of its own so that they work longer and harder when using it than they would on comparable paper and pencil tasks.

Computer assisted instruction has its roots in programmed instruction and in the behavioural theories of learning (Slavin, 1986). According to these theories, learning is accelerated by the use of controlled presentation of stimuli followed by reinforcement based upon the learner’s responses. Computer assisted instruction programmes stress drill practice exercises, teach students facts and concepts. Whatever their
differences, computer assisted instruction programmes generally share the following characteristics.

i) Use of structured curriculum.

ii) Letting students work at their pace.

iii) Giving students controlled, frequent feedback and reinforcement and

iv) Measuring performance quickly and giving students information on their performance.

There are different modes of computer assisted instruction. The most important of them are

a) Tutorial computer assisted instruction.

b) Drill and practice computer assisted instruction.

c) Generative computer assisted instruction.

d) Dialogue/ enquiry computer assisted instruction.

e) Simulation programme computer assisted instruction.

**a) Tutorial Computer Assisted Instruction**

In this mode, the course is broken up into small elements of information which the computer presents one by one followed by small questions. If the student gives correct answer, the computer gives further information. If he gives wrong answer, depending on the answer, the computer gives alternate supplementary information. If the student can now give the right answer, the computer advances on the main programme and gives further information and puts questions.

**b) Drill and Practice Computer Assisted Instruction**

In this approach, a list of simple problem is stored in the computer and the student communicates with the computer through a terminal. The computer presents a problem and if the student gives the correct answer, it gives the next problem list. If the student gives a wrong answer, the question is presented again. If the student again gives a wrong answer, depending on the programme, he is given the right answer or some supplementary information and then presented the next problem. The
computer can be used in this way for drill and practice of mathematical problems, spelling and grammar in language.

c) Generative Computer Assisted Instruction

Another way of using the computer for instruction is called generative CAI. In this form, the computer is programmed to generate questions within a basic framework about a topic. Questions can be generated randomly in which case different students get different sets of questions or the questions can be generated depending on the previous answer of the student. Generative CAI approach can also be used in tutorial CAI or Drill and practice CAI.

d) Dialogue / Enquiry Computer Assisted Instruction

Dialogue / enquiry CAI programme permits the student to conduct a limited dialogue with the computer. The student can put questions within the basic framework of the topic which the computer will answer. The computer may also put questions which the student answers.

e) Simulation Programme Computer Assisted Instruction

Simulation involves creation of real life-like situations for the purpose of experimentation and observation. Science experiments can be simulated and student can obtain the results of the experiment without actually performing it. This is useful where the substances to be used in the experiment are too expensive, too dangerous to handle, or the experiment is too time-consuming. One can think of numerous instances in natural and social sciences where simulation can be usefully employed. In Chemistry, there are experiments which are too dangerous to perform, but which can be studied under simulation. In biology, experiments may take a long time to obtain results; but the computer simulation can yield the result immediately.

In social sciences, experiments can be based on fictitious but consistent data obtained from survey and using statistical techniques, the result of any kind of intervention can be obtained. In Biology courses, the laws of genetics can be studied through computer simulation and genetic result of several generations can be obtained quickly. In medicine also, the
medical student can study through simulation the patients having rare diseases and their behaviour under different medical treatment.

Although simulation is a very useful method of learning, it should not be used where the skill of performing the experiment is important. Further, the simulation should not oversimplify the real life situation but closely correspond to it in important aspects.

**Significance of CAI as an Instructional Strategy**

Computers have come in to wield a greater influence in the field of education. It is an era of computers. Computer and internet play a vital role in the present day learning process not only in higher education but also in school education. The computer and internet can cater to the need of the students in any subject at any level in any place at any time. They have brought the whole world including books and persons into the drawing room or the study room which they are adorning. The educational values of computer assisted instruction cannot be underestimated. The tutorial CAI, Drill and practice CAI, Dialogue CAI, and simulation CAI have been verified and found to have been effective in teaching various subjects at school level (Ramar 1996, Reddy & Ramar, 1998 and 2000).

According to Rasmussen and Davidson (1996), one of the most powerful features of CAI is its capacity to individualize instruction to meet the specific needs of the learner, Self-paced instruction, the ability to present content in a variety of ways (i.e. text, audio, video, and graphics), and features such as hypertext, make CAI an effective learning medium. The use of CAI in classrooms has increased greatly over the years. As schools face continually growing problems with class sizes and heavier workloads, educators are looking at CAI as a means of enhancing instruction.

With the provision of multi terminals they have much distributing powers and they can reach out to many learners simultaneously. It is better than video instruction in the sense that one can interact with the computer. It is cost and time effective since the CDs are available at
cheaper cost, also, from a single CD any number of CDs can be got written at home or in the school or in the nearby computer centre. In the present era, where the personal computer is adorning the study or drawing room of most of the families, its relevance to instruction and learning is unique, immense and unparalleled. Further, computer assisted instruction can cater to individual differences to a greater extent.

**Various Categories of Students in a classroom**

A classroom is heterogeneous group. In each classroom there are students who differ from one another in a variety of ways. There are some students who demonstrate or manifest potential for high ability including high intelligence, high creativity and high task commitment. These students have cognitive superiority, creativity and a high magnitude of achievement motivation which set these students apart from the vast majority of the age mates. These students are called high achievers who constitute about 15% of the student population. They tend to be far ahead of average students and others in academic achievement.

High achievers tend to be happy and well liked by their peers. Most of them are social leaders at school. They are emotionally stable and self-sufficient and are less prone to neurotic and psychotic disorders than average children. They exhibit wide and varied interests and perceive themselves in positive terms. Recent research studies have abetted the misconception that high persons tend to be social misfits and emotional cripples. High achievers become upset and maladjusted when they are discriminated against and prevented from realising their full potential.

There are students who belong to the bulk middle order. Their achievement is neither laudable nor deplorable. These students constitute major portion of student population. These students outnumber the students belonging to other categories put together. These students are average achievers who just manage to pass without flying colours.

Sometime a large segment of school going children present a serious problem to schools because they have limited scope for
achievement. These pupils have intelligence quotients below 89 and they constitute about 18% of the total school population. Their ability to deal with abstract and symbolic materials (i.e. language, number and concepts) is very limited and their reasoning in practical situations is inferior to that of average students. These students are called low achievers.

Low Achievers differ slightly from normal children in learning ability. Research works (Saun G.S. 1980, Mishra, S.P. 1979, Koul L. 1978 Ramar, 1994) reveal that the attention span of low achievers is relatively short. They are also unable to deal with relatively complex games or school assignments. They need much external stimulation and encouragement to do simple type of work.

Every teacher knows at least some students who “could do better”. These are the students who come to school without books or homework and they seem to choose not to study for exams. They appear unphased by parents’ and teachers’ pleas that their grades will affect the rest of their professional lives. These students are commonly dubbed as underachievers.

Underachievement is most commonly defined as a discrepancy between potential (or ability) and performance (or achievement). Therefore, the students who appear capable of succeeding in school but are nonetheless struggling are often referred to as underachievers. Most of the literature on underachievement suggests that underachievers have lower academic self perceptions, lower self-motivation and self-regulation, and less goal directed behaviour, and more negative attitudes towards school, so their achievement is not in tune with their aptitude.

There are yet some other students who are unable to cope with the work normally expected of their age group. These students are termed as slow learners. These students with less than IQ90 are traditionally labelled “dull normal” and they are slower to ‘catch on’ to whatever is being taught if it involves symbolic, abstract or conceptual subject matter. But it is really
not that they learn so slowly as that they lag behind in developmental readiness to grasp the concepts that are within easy reach of the majority of their age mates.

There are a few students in any classroom who have disorders in development in language speech, reading and associated communication skills needed for social interaction. These students, in the absence of sensory defect or overt organic damage, have an intractable learning problem in one or more of reading, writing, speaking and mathematics and do not respond to normal teaching. These students are branded as learning disabled students. In addition to the above categories of students there may be handicapped students and students with special needs or impairments. A teacher can be said to be successful only when his instruction reaches out to the various categories of students in the classroom.

**Accommodating Instruction to Various Categories of Students**

Inclusive education lays stress on accommodating instructions to individual differences. Apart from physical and sociological individual differences, students are bound to manifest differences in learning aspects. These students differ from one another in a variety of ways in learning the given concept. To make his teaching more effective a teacher should take all possible efforts to accommodate his instruction to individual differences. This warrants different modes of instruction in the instructional process, which will be highly likely to cater to individual differences. This is what this study aims at. To make his instruction cater to individual differences a teacher should have a thorough knowledge about individual differences in students and how far different modes of instruction reach out to all the learners.

Heterogeneity is the mark of inclusive setting. A classroom is miniature whole of diverse elements. Even in a group there may be individual differences as discussed above. Heterogeneity is the underlying factor in any mainstream or inclusive setting. In any classroom under inclusive setting, there will be a few special needs children. There will be
some problem students and there will be low achieving students like under-achievers, low achievers and slow learners. Inclusive education emphasises including the excluded in general education classroom. All these diverse categories of students account for the heterogeneity in the classroom. The very objective of inclusive education is imparting instruction to these diverse categories under one umbrella. To do this task successfully a teacher should have a thorough knowledge about educational technology as well as instructional technology. Moreover, he should be able to decide upon the appropriate instructional strategy so as to make his instruction reach out to all the learners.

1.11. Need for CAI in Teaching Physics to Various Categories of Students at Plus One Level

Higher secondary level is a critical point for every student. It also serves as a turning point in a student’s life. But the sorry state of affairs that prevails now-a-days is not at all conducive for the mastery learning of the students, who have the aspirations burning like a flame in them to join professional courses. But, what the students, actually get in the classroom is a mere chalk and talk treatment. This amounts to doing deliberate injustice to the students.

In this technological era, if a teacher fails to incorporate different media sources, he cannot ensure mastery learning as well as high achievement. Moreover, a higher secondary teacher especially a physics master, has to develop autolearning by students to a great extent so that a sense of creative thinking and critical analysing can be developed in students. This warrants a special instructional strategy for the students at the higher secondary level, to learn any science subject for that matter. Computer assisted instruction is such a strategy. Almost all the units prescribed in physics syllabus easily lend themselves for development of CAI softwares. In each CAI there is provision for formative evaluation and summative evaluation. These enable the students to assess their progress and their level of competence. The practicum and the followup work suggested in the CAI add a practical approach to the learning of the
students. A material learnt this way will linger long in the memory. It provides for concrete presentation. So the students are able to understand the relationship and associations in a better way.

The careful incorporation of computers into a science course can and does add an important level of enhancement. Although not as conclusive as one might hope, studies do indicate that computer use in science education can improve learning and positively influence students’ attitudes and self-esteem.

CAI programmes ensure concrete presentation of instructional materials. So the student can overcome the problem of abstract thinking. Also, this approach ignites the spark of rational thinking in the minds of the students. Moreover, these CAI programmes carry the concepts from short term memory to long term memory to a great extent. When the concepts find a place in long term memory, they will lend themselves smoother for transfer, application and recall which are the ultimate aims of our instructional process.

Further, the CAI programmes take care of the following vital remedial programmes.

1) Grading of teaching materials taking into consideration the capacity and requirement of children.

2) Short frequent lessons instead of long lessons.

3) Giving importance to practice, drill, review, repetition and direction.

Inclusive education is still a new field. So there are no tested methods and techniques. Researchers have frequently visited inclusive schools and they have frequently observed the students, staff and their interactions in the actual classrooms. Moreover, they have made exhaustive interviews. On the basis of their observations and interviews of pupils, teachers and parents, some programmes have been found to be effective. These programmes are very effective with regard to various categories of students found in inclusive setting. The important programmes are as follows.
a) Accepting, accommodating and catering to diversities.
b) Devising instructions so as to reach out to all the learners.
c) Encouraging students’ participation.
d) Formal planning.
e) Overcoming barriers to learning.
f) Responding to category.
g) Responding to age.
h) Learner centred mode of instruction.
i) Promoting positive behaviour.
j) Providing help and support.
k) Principle of acceptance.

So the key note in inclusive education is accepting differences among the students and accommodating instruction to individual differences. This is very much accommodated in computer assisted instruction.

Finally, CAI programmes facilitate concrete presentation, clear demonstration and better perceptual grasp. From a critical scrutiny of physics higher secondary syllabus, it can be understood that for most of the units, a resourceful teacher can apply CAI softwares and the supporting multimedia packages. If the teacher takes a little pain, it will culminate in optimal gain for the students. CAI programmes in physics have the following advantages from the learners’ point of view.

i) The learners are involved in the learning process and their commitment to the task is increased.

ii) A large part of the CAI programmes will create interest among the students as it is a novel experiment.

iii) The students have the full control over the rate of study. So they can progress at their own pace.
iv) The consequences of failures are reduced. Each student can master each CD/programme completely before proceeding to the next.

v) Each student can participate in the decision whether he has learned the subject matter adequately.

vi) It may be practical for some CAI softwares to be checked out as study at home resulting in saving of time.

vii) Each student can develop a sense of responsibility for his or her own learning.

From the above discussions it is evident that there is a growing need for CAI programmes for mastery level learning and the need is in fact greater when the higher secondary students are involved in the teaching learning process. Though there are a number of studies in foreign contexts only a few studies are available in Indian contexts (Ramar, 1996; Kannan, 2009; Kumarasamy, 2008; Latha, 2009; Stella 1993). But no study has been made to verify the relative effectiveness of different modes of CAI with reference to various categories of students. The present study is an earnest attempt in this regard to apply CAI programmes for the physics subject in higher secondary syllabus and to measure the effectiveness of CAI programmes in teaching physics at higher secondary level.

The review of related researches is presented in the next chapter.