CHAPTER II

REVIEW OF RELATED LITERATURE

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A review of the previous researches and writings on the relevant areas directly or indirectly related to the present study is attempted below in order that it would serve as a suitable frame of reference for the present study. The materials that are available are grouped under appropriate heads and presented below.

2.1 Resources in Education

Science is so close to the life of every child that no teacher needs ever be without first hand materials for the study of science. The world above us, beneath us and around us in any part of the globe provides an inexhaustible supply of phenomena which can be used as a subject matter of science teaching, and of materials which can be used to construct scientific equipment and teaching aids.

Indian Science has made a tremendous progress since independence and every Indian can be reasonably proud of this fact. Unlike other developing countries, India had already an established structure of science education and research. But the gap between the science education abroad and in India has increased with time so far as physics
education and research are concerned. With the same resources India could have achieved more. In fact, along with the utilization of available resources for physics education, the country could have insisted on getting even more resources being put into physics education and research if it had planned for the distant future rather than for immediate interests.

According to Seay (1953), resources can be thought of as being natural, technological, human and institutional. By natural resources is meant those coming from nature, such as soil, minerals, water and climate. By technological resources is meant the tools of science and invention, such as cars, bulldozers, chemical analysis, aeroplane, etc. Human resources are the people and their potential energy. From the people and their understanding come the "big ideas" that stimulate action. Institutional resources are to be found in such organisations as schools and universities, churches and synagogues, research foundations, business firms and science association.

The term resources covers a very wide range of things, including time, money, people, ideas, products, space, facilities, power and even energy. The various resources available in education can be grouped into four major categories. (1) Physical resources (2) Financial resources (3) Human resources, and (4) Community resources.
The physical resources such as fixed capital installations, movable capital facilities, consumable items, are to be put to the maximum use in all the educational institutions. The fixed capital installations include both land and buildings.

The financial resources such as fee, endowments, returns from productive work etc., are to be used most economically. It refers to all funds available to educational authorities to spend on services and goods needed for educational operations.

Human resources in education means the time, labour and energy of the learners, instructional personnel and support personnel, including planners, administrators as well as parents, is by far the most valuable and expensive of all educational resources. For instance, the time of the school board members, members of the Parent Teacher Associations, parents helping to do home work, community members serving the curricular activities are very productive. These items are often not shown in the budget and usually not included in resource estimates.

The community resources provide dynamic, interesting and real life opportunities for teaching and learning. The community opens its door for experience through its resource people, field trips, etc.
According to Krupskaya, "We should learn from Pestalozzi the correct approach to life around us, and we must learn to take from it the knowledge and skills we need" (Krupskaya, 1985: 119). Pestalozzi lived at a time when Switzerland was still a poor country. He put forward a large number of suggestions concerning how to study in conditions of an obscure rural life and how to make use of the scanty resources that were available. The true practical workers even in the culturally most advanced countries teach the same things that Pestalozzi wanted to teach to children namely, how to make use of the world around them and how to acquire knowledge from knowledgeable persons.

Krupskaya (1985) emphasises the effective utilization of all available resources by saying use must be made of every electric power station, every railway workshop, every tractor, every sewing machine, every shop, every factory and every plant in acquainting children with modern technology in practice.

Science is not hardware. Science is in essence, a viewpoint, an ability to critically examine phenomena. From this viewpoint each and every object of daily use is piece of scientific apparatus and every child is an explorer - a potential scientist we must look critically at our own resources and possibilities.
The value of resources depends on how skilfully they are used. Each should be used for a definite purpose, to help solve a problem, to make a scientific principle more graphic, to increase the tendency of pupils to inquire about their environment. Most educational systems or educational institutions do not consider as a major and central objective the optimal use of inputs to maximise their outcome. Ficher and Orivel (1980) observe that most countries, especially the poorest are facing budgetary difficulties which have stopped the expansion of public resources allocated to education. After a quarter century of rapid expansion of public resources allocated to education (1950-75), public authorities and public opinion are increasingly concerned with the idea of a 'good' use of these resources.

At the heart of the controversies surrounding public education is the strongly held belief that schools should have a 'positive impact' on their clientele. "The impact of school depend on the quantity and quality of resources and also their effective utilization. Impact implies 'effect', and 'effect' implies 'cause'" (Spady, 1976: 186).

In U.S.A., many studies have examined the relationship between school resources and student achievements. Most of these studies have been summarized
by Guthrie, et al. (1971) and Averch, et al. (1972).

The finding of the study by Ribich (1968) suggest that beyond a certain point schools cannot effectively utilize all of the available non-human facilities.

A review of literature and studies regarding the institutional resources such as school building, class room, playground, library, laboratory, audio-visual aids, environmental resources, in-service programme, etc., is attempted under appropriate heads.

2.1.1. Site, location, building, classroom and playground

School buildings can provide the desired physical facilities to meet the needs of the students. The notion that planning precedes building is expressed very well by Lewis and Wilson (1953) by quoting a bulletin of the Michigan Department of Public Instruction: Good buildings do not just happen. They must be planned carefully and thoroughly. School building planning should recognize the essential difference between planning for school building and planning of school building. The purpose of school building is to provide the physical assets essential to the educational programme. Planning for school buildings is the process of defining and stating the kind and extent of the educational programme to be housed in school building or buildings and, the development of a long-range building
programme. Planning of school building is the process of developing a school building suitable to the educational programme described in planning for school buildings.

According to the Kerala Education Rules (KER, 1958), every school should normally have a minimum site area as specified in the following schedule.

<table>
<thead>
<tr>
<th>School Type</th>
<th>Site Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower primary schools, Upper primary</td>
<td>4 to 8 Hectares</td>
</tr>
<tr>
<td>schools with or without primary section</td>
<td></td>
</tr>
<tr>
<td>Secondary schools (High schools)</td>
<td>1.2 to 2 Hectares</td>
</tr>
</tbody>
</table>

The site should be located in a healthy place in the centre of a village or town. The site for the school should be large enough to cater the modern educational needs. The school site should be so selected as to keep it as far as possible from the noise and dust of the busy roads and such other distractions. The site should provide for adequate playground, gardens etc. Shady trees should be planted in such a way that it will be very useful to children. The site should be provided with compound wall or good fencing. "A good building, it must be admitted is a most vital asset for a school and a poor physical environment can become a great handicap in developing the proper esprit-de-corps or enduring tradition or a sense of loyalty to the institution" (Saiyidain, 1955 : 91). The school building should satisfy the triple conditions of
functional efficiency, beauty and economy. School buildings are not built for the past or even for the present but they must be planned for the future.

The building constructed at times, are not properly maintained for use. It will be generally agreed that the facilities in Indian educational system, deficient as they are, are not utilized to their full advantage. It is the duty of the heads of the institutions to find out the immediate needs taking into consideration the resources and funds available. Giri (1976) studied the various problems felt by schools and stressed the importance of institutional planning as there are a thousand things to be done which requires crores of rupees which we do not have and, instead things could be done with no money or with little money. He stresses the need for maximum utilization of the material resources and human resources. The maximum utilization of physical resources is also emphasised in the Report of the Education Commission (1964-'66) by pointing out that "It is very costly to provide and maintain the physical plant of educational institutions, it becomes necessary to utilize it as fully as possible, for the longest time on each day and for all the days in the year, by making suitable administrative arrangements. Libraries, laboratories, workshops, craftsheds, etc., should be open all the year round and should be utilised for at least eight hours a day."
Teachers, students and local community members themselves should discover innumerable methods of utilizing school facilities to the maximum potential throughout the year" (1964-'66 : 40).

Oddie (1966) in his study examined the problems and expenditure involved in the optimum utilization of premises, the area required per pupil, the cost per unit of floor area and required per pupil, the cost per unit of floor area and standards of performance. He presented a methodology of building cost analysis and also dealt with questions concerning : increasing the effectiveness of existing school building, rate of investment, bulk purchase and forward programming.

In India the classroom is the most important unit in which instruction is going on. This is all the more true in the case of Kerala which is a thickly populated State of India. Kerala Education Rules (1958) is very specific in prescribing the dimensions of every classroom in upper primary and secondary school (high school or higher secondary school) should be 6m. x 6m. x 3.7m. and in a lower primary school 6m. x 5.5m. x 3m. The superficial area of the floor, the cubic content of the room and the maximum number of pupils that may be accommodated should be clearly recorded. In this context the standard prescribed for schools in England is worth mentioning. The standard
prescribed by the Board of Education in England is 10 sq.ft. for every pupil under 11 years and 12 sq. ft. for those over twelve.

Effective science teaching is an interaction between children, teachers, materials and equipments and facilities. For the progress of science studies, the school should contain adequate facilities and materials. Teaching is usually done by the classroom teacher in the regular classroom and so he should also have a planning for purchasing and constructing science facilities and materials. "Flexibility is a key to a suitable science teaching facility .... This flexibility of classroom facility makes it easy for the teacher to convert any classroom into an effective learning centre" (Anderson, 1970: 192).

According to Jacobson (1970) 'A self contained classroom' should have the following arrangements: classroom as a laboratory, a science activity centre, a centre for life science activities, work storage area, a science library, a science resource file, etc., whereas 'a science room' should have a ready accessibility, natural lighting, storage facilities for books, maps, chemicals, materials, etc., work benches, demonstration units, work areas for students, outlets for water, gas and electricity, chalk, peg boards, clock with sweep second hand, T.V.
antennae connection, locked storage for audio visual equipments, dark rooms, etc.

The science classroom and laboratory are the key places where intentions ought to be translated into actions and where both the teacher and the learner are involved in realizing the curriculum objectives. Schools in this century is more than a place where academic skills are taught and learned, it is a miniature community where members interact and influence the behaviour of each other. Optimizing classroom environment and facilities for students is one of the most important goals for teacher and schools. Hofstein, Yazer and Walberg (1982) in their study observe that their findings are in harmony with ideas suggested by Bloom, that the atmosphere and environment in which students encounter science affects attitudes towards science and their achievement towards science.

According to the Kerala Education Rules (1958) the maximum strength of a class shall be 40, but excess admissions upto 45 will be allowed. When there are more than 45 students a second division may be opened, when the strength exceeds 85 a third division and so on. Excess admission upto 50 in a class division may, however, be made with the permission of the Director.

In the choice of furniture - utility, strength, mobility and appearance should be considered. But there is
a sharp conflict between what is desirable educationally and what is practicable economically. Although the KER suggests that every school shall be provided with a minimum of durable furniture of suitable dimensions and specifications approved by the Department, many schools of Kerala do not satisfy this condition satisfactorily.

The study conducted by Pillai (1956) was aimed to find out how far the organisational and administrative factors affect the achievement of pupils in secondary schools. The study revealed that sitting accommodation and facilities for writing in correct posture, in a large number of schools are quite unsatisfactory. In many schools furniture, library, laboratory, teachers' rooms, etc., were not provided and in certain schools the strength of the class went up to 70.

Desai (1966) conducted an evaluation of the secondary schools of Gujarat State and the study revealed that the position of physical facilities is generally satisfactory in all the schools.

The lack of proper school facilities is reported by many researchers (Bose, Banerjee, and Mukherjee, 1965; Mandalia and Najamuddin, 1975; Peter, 1984; and Nair 1986).

It is believed that the institutional facilities are poor in most of the Indian schools especially in rural
areas. The specific objective of the investigation carried out by Govinda (1980) was to appraise the quality of existing schools in rural areas in terms of physical accommodation, playground, science equipment, library, extra-curricular activities, teachers, incentive schemes in operation and extent of wastage. His major findings are:

1. Many of the classroom were overcrowded and physical accommodation inadequate.
2. Except for a few cases there were no playgrounds or sports equipments in any of the schools.
3. Facilities in terms of science teaching equipments were at an extremely poor state in most of the schools.

The outcome of the study undertaken by Balakrishnan (1965) also confirms the lack of proper accommodation and facilities such as buildings, library, laboratory, store-room, games room, etc.

The playground is said to be the cradle of democracy. It is often quoted that the battle of Waterloo was won in the playground of Eton. It is on the playground that one learns to respect the rights of others and to obey the will of the majority. The child merges with a group and learns the spirit of self-sacrifice. It also helps quick thinking, practical judgement and formation of character. Hence without proper physical education, education will not be complete.
The Study conducted by Perimbamuthoo (1958) reveals the following facts regarding the physical education facilities in Kerala schools: (1) Most of the schools are without proper playgrounds. (2) Ground facilities are meagre. (3) Equipments are inadequate and often even available equipments are not properly used. (4) Often the funds allocated for purchase of physical education equipments are not utilized. Roy (1960) attempted an investigation into the provision for physical education in the schools of Howrah and the finding were in agreement with that of Perimbamuttoo's.

Unnithan's (1969) study reveals that the provision of compound area, playground, garden and compound wall are far from satisfactory in most of the schools of Kerala State.

2.1.2 Library

A well-equipped and well-managed library is indeed the foundation stone of any modern educational structure. School libraries develop in pupils the ability to learn from books even without the assistance of teacher. The necessity for having many kinds of reference books for effective science learning becomes imperative. A good text book is a source of knowledge arranged systematically. It enables pupils to acquire the needed information speedily. The
science teacher should get the choice to select books for his pupils, as, even the best book omit some details which is needed, for this he should be guided by the following factors: correctness of matter, purity of language, simplicity and clarity of illustrations, quality of printing, etc., in the case of textbooks and direction for fitting up the apparatus, precautions, methods of recording, lists of experiments etc., in the case of laboratory manuals (Dass, 1949).

The teacher should give directions to the pupils to use the books effectively. Some of the matters presented in the book may need some elaboration and explanation in certain cases. Much of what is presented in most textbooks in the hands of students need elaboration, summation, and alternate presentation by the teacher. Many high school students do not have the practice and discipline to study carefully textbook material with the view of mastering the subject on their own (Kutliroff, 1970).

Best materials for science courses can be obtained from different sources, provided the sources of information must be reliable and up-to-date. Nunn (1956) has classified the sources of information as the local sources, national scientific societies, information from government sources, information from private enterprises, reports of research institutions, national libraries, journals and reports from other schools.
Studies have indicated that the type of reference material used in the instruction of a science course can and does affect the learning outcomes. Yager (1965) reports that use of multi-references in the teaching of physical science can affect such learning outcomes as skill in critical thinking and ability to understand the nature of science and the men who practice science.

As far as printed educational materials are concerned Eaton (1963) and Williams (1963), found that same materials are not necessarily suitable for all students. They hypothesized that through suitable manipulation of appropriate factors, it should be possible to reproduce materials which will result in maximum learning for all students.

School libraries provide different types of books and reference materials. Vora (1975) studied the role of libraries in primary and secondary schools and the findings reveal that effective use of libraries are not taking place in the schools.

Maucall (1978) in his study provides a description of the use of libraries and library resources by academic high school students preparing papers for wide-pendent study projects. The following were some of the findings:

(1) Students successfully seek information in more than one
type library. (2) The students see library as places to receive assistance.

The findings of the study conducted by Barki and Bhat (1981) reveal that libraries were not put to optimal use by students and the teaching methods used by teachers did not encourage to use their institutional libraries. They also reported that the physical environment of the library was not conducive to reading in the library.

A more recent study by Al-Musalam (1988) revealed that most libraries in Kuwait still need more space, and better organisation, as well as additional equipments, books and materials. The existing conditions hinder complete utilization of libraries by students and teachers.

The science teacher is often faced with excluding the library from his/her teaching programme or developing a programme that reduces the dependence on reading and writing skills; in this situation the students are not being encouraged to use the library resources (Havel, and Treagust, 1989).

Though a well equipped library should be the prime requisite of every school, it is pointed out that many of the Indian schools do not have adequate library and laboratory facilities. This is revealed through the studies of Murthy (1964); Bose, Banerjee and Mukerjee (1965); Rao (1968); Kalra (1976) and Govinda (1980).
2.1.3 Laboratory

All the new science-teaching programmes accept the principle that understanding comes through the pupils doing experiments themselves, so direct, first-hand experience is a must for children learning science. Talk and chalk alone give little feeling for science, encouraging an authoritarian factual approach. Good demonstrations by the teacher may help a little, but it is only when pupils come to handling the apparatus that they really accept the phenomenon concerned. The knowledge acquired in this way is something of their own, no longer something second-hand.

Since experimentation involves 'learning by doing', there can be no substitute for it. Pupil experimentation is an essential part of good sciences education. Opportunities should be provided for the pupils to perform experiments since the primary purpose of experimenting is to secure evidence which may reveal answers to many problems. Each pupil should be encouraged to observe and record exactly what he observes. This will help to develop healthy scientific attitude, appreciation and also provides training in scientific attitude, appreciation and also provides training in scientific method. Students should be encouraged by their teacher to participate in experiences which offer opportunities to develop skills in
planning experiments with equipment and conducting experiments.

At the elementary level, a great deal of physics can be learnt using the most simple local resources. But the needs of secondary physics education are a little more sophisticated. The nature of physics is such that some apparatus is essential for its teaching. While stressing the importance of apparatus in physics teaching at secondary level Norman, et al. comment, "A country which starts by saying that it is a poor country which cannot provide apparatus and needs supplies of paper cut-out models to illustrate the principles of electricity should probably not attempt to teach electricity at all in its secondary schools" (Norman et al., 1972 : 173). Physics is an experimental science and it is very important that the children get personally involved so that they come to understanding. Personal involvement occurs when children do experiments themselves, and doing experiments implies the need of apparatus. So the need to provide apparatus cannot be overlooked by any one wishing to improve the quality of physics teaching.

'Hear and forget, see and remember, do and understand' is widely accepted as the ideal for physics teaching. For this to be achieved, apparatus for pupil experiments must be available in large quantity, whenever
feasible experiments should be done as class experiments with pupils working individually, in pairs or at the most groups of four. It is true that sometimes this is not practicable - mainly due to two reasons. The apparatus needed may be too expensive for the school to have it in quantity and the second reason is the time factor: it may not be possible to complete the course if each pupil did experiments individually.

In most Indian schools, individual pupil experimentation is rather difficult due to lack of laboratory facilities. Where there is no facility for individual experimentation, at least facilities for group experimentation must be provided. Research evidence indicates that pupils working in pairs derive less benefit from an experiment than do pupils working individually. The difference however is not great enough to justify the added expense of providing individual sets of equipment for all experiments.

By analysing high school textbooks and laboratory workbooks in several sciences and interviews with science teachers, Pella (1961) reports the vivid functions of laboratory as follows: laboratory is a means of securing information, determining cause and effect relationship, verifying certain factors or phenomena, applying what is known, developing skill, providing drill, helping pupils
learn to use scientific methods of solving problems and carrying on individual research.

Review of research on the role of the laboratory in science show that it is an excellent instructional mode (Bates, 1978; Hoftstein and Lunetta, 1982).

Various studies have been conducted to examine the effect of laboratory experiences on students' attitudes. The purpose of the study conducted by Hajji and Youseef (1983) was to assess attitudes of students and science teachers towards science laboratory work in the middle schools of Kuwait. The result of their analysis indicate that the middle school students in Kuwait find science laboratory work to be necessary, interesting and helpful to them in learning science. Girls expressed as much interest in science laboratory work as boys did. Science teachers in general seem to agree that their students are sufficiently interested in and are able to perform satisfactorily in the laboratory. The findings of the study conducted by Ben-Zvi, et al. (1976) also reveal the positive attitude of High School students towards laboratory experiences.

The science classrooms and laboratory are key places where intentions ought to be transformed into actions, and where both the teacher and the learner are involved in realizing the curriculum objectives. Since classroom environment is an important component of the
teaching learning process which, aside from instruction, predicts learning, the use of learning environments measures in research studies concerning the effectiveness of laboratory work should not be overlooked. This is quite in agreement with the findings of Hofstein, Gluzman, Ben-Zvi and Samuel (1980). Their research study was aimed at examining the question, "What is the role of laboratory work in influencing students' perception of their classroom learning environment?"

Although a well equipped laboratory is a must for physics education, the laboratory facilities available in most of our schools is far from satisfactory. Kalra (1976) conducted a study to determine the conditions of laboratory facilities in Indian high schools. He concludes that there is a definite need for more and better laboratory facilities and equipments, library and other materials related to science teaching.

Studies conducted by Nair (1981) and Cherian (1987) throw light on the conditions of libraries and laboratories in the schools of Kerala. According to them the laboratory and library facilities do not seem to be encouraging.

Many studies have been conducted to investigate the laboratory facilities in Indian Schools (Bose, Banerjee, and Mukherjee, 1965; Rao, 1968; Govinda, 1980). They all
report the poor and inadequate laboratory facilities and lack of good quality equipments in our schools. The condition of Kerala schools are also not an exception. This is revealed through the studies of Jacob (1969); Bose(1976) and Raju (1985). Proper laboratory facilities are available only in some selected urban schools. They report that most of the schools are not utilising even the available laboratory facilities although the facilities are inadequate and unsatisfactory. They hold the view that the school authorities and the government should take steps to improve the conditions of laboratories in our school so that the science education provided will be effective and meaningful to pupils. This will help in improving the quality of our science education. Without a proper laboratory and library, it is difficult to impart science education.

Rajput, Gupta and Vaidya (1978) observe that due importance to practical work is not provided to pupils. They conducted a survey to study the role of laboratories in the basic education of science as perceived by science teachers. Their findings include: (1) 68.73 per cent of schools had no water supply. (2) 91.43 per cent of schools had no gas supply. (3) 10 per cent of schools did not have laboratory. (4) Practical work was not attempted in Class IX in 55 per cent of schools in Maharashtra. (5) Main problems faced by the teachers were: lack of free time for them to arrange for
practical work, poor quality of equipments and materials supplied by firms offering lowest quotations, etc.

If science apparatus is to be successfully handled by secondary school pupils, it must be simple to manipulate and should lead as directly as possible to the concepts being developed, criteria which are not always satisfied by equipments of simple design and cheap construction.

The criteria for selecting the use of science equipment is a very important aspect of science education which the science teacher has to bear in mind. An analysis of a panel-validated questionnaire survey conducted by Ricker (1963) indicated that teacher preparation to use equipment varied as did most equipment available to that teacher.

The study conducted by Peter (1984) throws light on the factors leading to wastage of resources in the school education of Kerala. The findings include improper utilization of land and physical education facilities, lack of proper library and laboratory facilities, non-effective utilization of time, and community resources, etc.

The investigation carried out by Sadhana (1986) revealed the fact that the library and laboratory facilities are not adequate. Majority of schools in Kerala are not having adequate number of required teaching aids and many of the schools are not utilizing the available aids
effectively. Physical facilities like building, classrooms, playground etc., are insufficient.

2.1.4 Audio-visual Aids

To be effective, science teaching should be built around concrete experiences which makes abstract ideas meaningful. The proper use of audio-visual aids by science teachers will enrich and vitalize their instruction and help the pupils develop correct concepts. Various forms of visual and audible aids can be great assets to the teacher and can promote effective teaching of physics.

It has been said that audio-visual aids can 'bring the world to the classroom'. This means that they can bring some of the characteristics of real experience within the reach of the pupil. They are no substitute for real experiences, but they can motivate and inform, and in some cases can do even better than the real experience. A visit to a hydroelectric plant, for example, may be more impressive and motivational than seeing a film about it, but an understanding of the workings of a dynamo can perhaps be achieved more rapidly with the help of well-designed film or film loop (Ootuka et al., 1972).

Great educators like Rousseau, discouraged the use of more words in education. He advocated that nature of body, mind of a child and his surroundings should be taken
into account. As a result of this, shift took place from teacher to child-centred education.

Educators especially Frobel have long noted the importance of providing a sufficient quantity of auditory, visual, muscular and other impressions to children from their early years and of systematising them, and providing opportunities for children to constantly exercise their external senses. Children seen to observe since a very early age. They should be taught to do this. The system of toys designed by Montessori intends to encourage the small children to learn to observe and exercise their senses by selecting toys rather than by the use of words (Krupskaya, 1985). The need for providing direct and concrete experiences to pupil is emphasised by modern education lists also (Piaget, 1959; Gagne, 1977 and Bruner, 1960).

The content of science is so vast that we cannot expect pupils to have direct experience. They cannot do all the experiments. The next best thing is to bring the experience to the pupil so vividly through sight and sound that he is put on the road to understanding.

Previously the emphasis was on teaching. Now the trend has been to shift the emphasis from teaching to learning. Audio-visual aids can be designed to assist in the basic aims of education, which include both learning and understanding. Some audio-visual aids do this best through
information others through motivation and still others provide both.

The recent developments in educational technology and instructional media are not only innovations in the pedagogical procedures but also present a challenge to the inclined to stick to the traditional methods of classroom teaching. Teachers are becoming increasingly aware of the utility and need of the audio-visual technology in enriching the teaching-learning situation.

Audio-visual perceptions give interesting, joyous and real appreciation of the concepts. It enriches and improves everyday life, adds fullness to life and makes two important senses more acute. Harold et al. report "The researches conducted by Charles F. Hoban, James D. Finn and Edgar Dale have found that audio-visual materials in the teaching situations, can accomplish the following: (1) They supply a concrete basis for conceptual thinking and hence reduce meaningless word response of study (2) They have a high degree of interest for students (3) They make learning more permanent. (4) They offer a reality of experience which stimulates self activity on the part of the pupils (5) They develop a continuity of thought (6) They contribute to growth of meaning and hence to vocabulary development. They provides experiences not easily obtained through other materials and contribute to the efficiency, depth and
variety of learning" (Harold, et al., 1962: 84).

Bruner (1969) has classified the devices according to the type of experience attained by pupil. Films, Television, Micro-photographic film, film strips, sound recordings and the like are the devices for vicarious experience. 'Sequential programmes' are most subtle devices used to lead the student to a sense of the conceptual structure of things he observes. PSSC and others are excellent instances for this.

Chalkboard still remain as the least expensive and most universally used visual aid. The second most important visual aids are books. Highlighting the importance of books in Physics education Ootuka, et al point out, "Any teaching of Physics will ultimately need well-prepared books, but there is frequently a lack of proper understanding of the role of book, what it should contain, how to illustrate it and how to make it appealing. Cutting the cost of illustrations is common, and at the same time the ones appearing may be useless..... There is plenty of scope in Physics books for using latest techniques in providing illustrations" (Ootuka, et al., 1972: 216).

The other commonly used audio-visual aids in the teaching of physics are slides, film strips, the overhead projector, films, film loops in cassettes, tape recorder, auto lecture, radio, television, etc. Although abundant in
quantity the audio-visual aids are very heterogeneous. The proper selection and effective use of these aids is a very important task for the physics teacher.

Sound guidelines for using instructional materials are imperative if maximum values are to be achieved. Principles that teachers can use in guiding the use of materials are just as important as the materials themselves. Learning can be hindered if haphazardness and carelessness characterize the use of resources. Same painstaking care that is given to the selection of materials must also be given to their use.

The common problems reported in UNESCO-NIER workshop Report (1971) in the utilization of audio-visual aids are: (a) Insufficient in-service and pre-service training of teachers, (b) Insufficient maintenance and repair facilities (including technicians) teachers often do not ask for replacement when audio-visual aids are mislaid or broken, (c) lack of expendables, e.g. ink, special paper etc. and spare parts, (d) Lack of electricity - The rural areas of most Asian countries are not supplied with electricity, therefore there is a need for battery-operated equipment to be used in such areas, (e) lack of suitable equipments, (f) Lack of suitable software, (g) Distribution problems, (h) Poor storage facilities, and (i) Unsystematic utilization of audio-visual materials.
Ahluwalia and Aggarwal (1970) studied the extent of the use of films and filmstrips as a medium of instruction in secondary schools in Tamil Nadu. They have reported that 249 schools possessed 35 mm. film strip projectors along with 16 mm. filmstrip projectors and 227 projectors were in working order. The general feeling of the school was positive towards the advantages of the films.

In another study, Khanna (1970) surveyed the source materials in filmstrips and books on audio-visual education. It is reported that the materials were classified under the heads - art, communication, craft, film, filmstrips and slides, graphics, mechanical aids, printing, photography, puppetry, television, radio, etc.

Kozloski (1974) has reported that use of simple line drawing posters in the laboratory transmits ideas to all the students without individually stressing each point. They can be used to introduce new ideas, give directions and classify operational definitions.

An investigation by Kathy and Bruce (1983) revealed that the television scheme played a dominant role in organising the content into a meaningful whole. But they were of the opinion that the viewing experience became a mere 'active' process.

It is quite evident from the studies of Carpenter (1958) and Lawrence (1957) that the audio-visual method of
teaching is more effective than the text-book method. While comparing the achievement of students taught by three different techniques - the textbook method, the pupil activity method and the audio-visual method - they observed that pupils taught by pupil activity method ranked highest, those taught by audio-visual method ranked the second and those by the text book method, the lowest. Dwyer's (1971) study also reveals the effectiveness of visual instruction in classroom teaching.

Audio-visual aids help to develop creative thinking while adding novelty to the teaching process. Sonar (1978) attempted to locate the spots in the primary school syllabus wherein filmstrip teaching can be resorted either to supplement laboratory work or to revise, present new matter, and stimulate interest. It is clear from his findings that science syllabus can be effectively taught with the help of film strips. The use of these instructional aids indicate the possibility of improvement in methodology of science teaching.

Rao (1972) conducted an investigation to trace briefly the evolution and use of audio-visual aids in instruction and to critically evaluate the various methods following to make the maximum use of these aids in classroom. The study revealed the following facts. (1) Certain progressive schools of big cities like Bombay,
Poona, etc., were definitely advanced in the use of audio-visual aids than the schools in villages. (2) Maps and charts were most commonly used aids, but certain progressive schools were also using film projectors. (3) Many schools in spite of their liking for film and radio, could not afford to have them due to want of funds.

Phuleta's study (1981) regarding the utilization and comprehensibility of school Television programmes in Delhi schools revealed that only 38 per cent schools in the sample possessing Television sets were utilizing school Television Programmes.

The outcome of Golani's (1982) investigation were the following: (1) There was non availability of trained personnel in audio-visual education (2) Accommodation of equipments was a problem in many schools (3) The audiovisual aids being expensive the schools could not purchase them. Sophisticated aids were out of question.

The results of the study conducted by Joseph (1988) establishes the importance of having the maximum use of audio-visual aids in the classroom teaching for the enhancement of teaching-learning process.

2.1.5 Co-Curricular activities

Co-curriculum is the term used for out-of-class activities which include science clubs, science fairs,
science congress, etc. According to Lacey (1968), the main purpose of co-curricular activities are the following: it enriches formal curriculum, provides for individual difference and interest, establishes better teacher-student relationship, provides appropriate activities for student groups, brings students together on a common basis.

Co-curricular activities can provide an outlet for the pent-up emotions of children and channelise their energies toward desirable goals. These will help in satisfying the instincts and urges of children and making them full-fledged personalities. These activities cater to the inculcation of scientific attitude, a genuine interest in science and scientific activities, supplement classroom work and laboratory work and put the syllabus on a practical bias. The students learn the things without the conscious effort on their part and pursue science as a pleasant hobby and not a burden on them.

In an age of science that is affecting our daily lives and controlling the destiny of mankind, there is no lack of stimulus to the imagination of young minds. No curriculum, no course study, no text-book can ever be sufficiently up-to-date.

Educators know that the ideal solution to this problem involves an integration of the curricular activities and co-curricular activities. Teachers can utilize co-
curricular activities for the purpose of strengthening the goals of instruction.

The usual way of teaching science subjects inside the class-room does not give full scope for learning. It is true that much can be learned outside the classroom as co-curricular activities. Science clubs, which have now become a part of every school, are good laboratories of students for experimentation.

Washton points out the use of science club as "Science club provides an opportunity for sharing ideas, for carrying out scientific projects and for realising the joy that comes with accomplishments which are recognised by one's peers" (1961: 43). Sharma (1982) emphasises the need of science clubs upto higher secondary stage which can provide a large number of activities and thereby, widen and deepen the interests of pupils and provide means of developing desirable ways of utilising leisure time.

Science club activities play a vital role in the identification and development of science talents. "It is important to identify the potentially talented students at the secondary school stage through science talents search, since failure to identify a child may spell disaster because the child may get wrong training and enter into wrong vocation thereby causing not only a personal but also a national wastage" (NCERT, 1967: 47).
Students should be given the opportunity to reveal their inclinations and to test and exercise their abilities in various types of activities. In this regard the school science club can play a major role. There is a vast educational literature dealing with science clubs and related activities.

The study by Clean and Dudleston (1933) revealed that pupils who were members of high school science clubs excelled non-members in scientific knowledge.

Sreekumar (1972) conducted a study to compare the science interest, science aptitude and science achievement of science club members and non-members of high school. Significant difference in the science achievement of science club members and non-members was reported and found that science club members were superior to non-members.

Varghese (1979) studied about the performance skills of members and non-members of science club and found that club members were superior to non-members in performance skills.

The studies conducted by Andrew (1980) and Sumam (1980) confirm the need for systematic planning for proper interaction between classroom learning and science club activities.

It is evident from Noorjehan's (1983) study that there is no deliberate planning for a super structure of
work in the science club over the base of classroom learning.

Even though the significance of science club activities are recognised, the way of physics learning through science club activities is yet to be properly explored. Sivadasan (1988) holds the view that there is no systematic interaction between science club and classroom activities in the teaching of science in Kerala State. He emphasises the need for linking class teaching with science club programmes.

Science fairs and exhibitions have become an integral part of science education because of their immense importance for developing in the student scientific interests, skills and expressions through their displays in the fair. The outcome of science club activities will also benefit science fairs and exhibitions. The greatest contribution of these lie in the recognition and encouragement that they give to students' participation.

The objectives of science fairs have been listed by Gupta (1981). They are: (1) To focus attention on science experiences in school (2) To stimulate a great interest in science by all pupils (3) To stimulate a greater interest in scientific investigation over and above the routine class work (4) To provide stimulation for scientific hobby pursuits (5) To offer an opportunity for display of
scientific talent through exhibits and demonstrations (6) To
develop the habit of extra study and provide useful means of
occupying their leisure.

Careful planning is necessary for the success of any science fair or exhibition, several committees have to work individually and collectively for its success. If different schools of the same locality collectively organise a science fair it can be made more impressive to the public. This will help to bring out originality, creativity and technical skill and provide valuable experience. This will create in students a desire for scientific research and investigation. The multitude of exhibits can be stored and utilized effectively for co-curricular enrichment which form valuable resources for physics education.

Discussing about the importance of science exhibition, Ahmed writes: "The educators today are trying to make science education exhaustive. They are trying to popularise scientific knowledge and make it functional and relevant to society. It is in this perspective that the organization of science exhibition at National, State and District levels should be viewed" (Ahmed, 1979 : 11 and 12).

Varghese (1982) conducted a study on the immediate and long term values of science exhibition and it reveals that the exhibits have a very good coverage in terms of the topic prescribed in the syllabus.
Bridget (1988) studied the extent of pupil participation in science fairs. The study revealed that majority of participants had benefited through their participation with respect to knowledge, inspiration, creative thinking, skill development, etc.

Science fairs can be fun and rewarding experiences for all students and teachers. McBride, Zook and Lanib (1987) studied about classroom science and mathematics fair. They conclude that the affairs provide an opportunity for all students to achieve success. Successful experiences foster positive self concept and positive attitudes towards other school activities. Although fairs are time consuming, the benefits derived from a good experience will far outweigh the effort expended.

The above discussion about Co-curricular activities provide considerable evidence to support the belief that these activities in science compare most favourably with curricular work in science in terms of educational outcomes of many kinds. These activities help to bridge the gap between theory and practice and cater to the development of practical application awareness.

2.1.6 Environmental resources

It is necessary to take into account the potentialities of science as a factor in the successful
adjustment of children to the world which surrounds them. The children must be trained to see their environment as something that can be studied and utilized. If pupils are to study the environment, the teacher should himself explore the materials and situations in the local community. Such a study will reveal richer resources than one usually is aware of.

When pupils are motivated to learn science incidentally, they will find science everywhere – even outside the classroom and laboratory. Many of the materials in the environment which can be used effectively in science teaching/learning are permanently fixed and cannot be studied in the laboratory or brought into the classroom.

There are many environmental resources that can be exploited for science teaching. A study of one's own environment, whether farm, city, small town or sub-urban area, can be very rewarding. As local resources differ widely within a particular country as well as from one country to another, it is anticipated that each teacher will draw from it materials appropriate to the needs of his or her own pupils and the particular teaching situations. The wealth of environmental resources for teaching science should be revealed to teachers through pre-service and in-service programmes of education so that these resources will be utilized more effectively (Henry, 1947).
Review of literature shows that several investigators have mentioned about teaching situations or environmental resources of urban and rural localities (Henry, 1947; Washton, 1961; Selberg, et al. 1970; UNESCO, 1978). It is clearly the obligation of teachers and supervisors to survey school communities and nearby areas to find out what resources are available. Then these resources can be utilized effectively as part of science facilities.

Direct contact with nature and natural phenomena enables the child to meet concrete problems that concern him and stimulates reflective thoughts and manipulation of knowledge. It provides chances to apply textbook knowledge in an interpretation of local phenomena (Anderson and Kautnik, 1972).

Outdoor learning environments provide stimulation for factual knowledge. Further more it provides chances for children to explore and internalize the meaning of what they see and hear. They provide chances for activity, freedom to move, to explore, and to experiment which in turn will contribute directly to the discovery learning and afford chances for grasping the true spirit of science. Out of school activities are effective in breaking the monotony of classroom activities, and this way add to student motivation.
Osborn and Spofford (1970) are of the opinion that the proper utilization of outdoor study area will provide opportunity to understand the interdisciplinarity existing between different disciplines.

Blum (1981) conducted a survey of environmental issues treated in science education curricula before and after 1974. Use of resources were dealt within nearly all Environment Science Education Projects surveyed before 1974.

Exemmal (1974) conducted a study on the use of environmental and ethnic resources in the teaching of primary school botany. Her study reveals that although teachers conduct excursions, only on-fifth of them claim to have used these activities for teaching botany.

Nair (1981) and Cherian (1987) report significant correlation between the availability of environmental resources and the extent of their use. Their study reveal 'home' as the best environmental resource to facilitate physics and chemistry teaching.

One of the objectives of the investigation undertaken by Rajput and others (1980) was to identify the available community resources which can be gainfully utilized for teaching at Primary level. Manuel (1982) identified some typical resources other than textbooks which can be useful for environment education.
Field trip is an instructional medium that possesses potentialities for enriching and extending the educational experiences of pupils. A field trip offers opportunities for pupils to observe directly and experience what they visit. It offers an excellent link connecting the teachers to relate classroom instruction to the practice of life itself (Smith, 1961).

The general potential of a field trip to a hospital is studied by Ellis (1976) and reports that the potential lies in the possibilities it offers to demonstrate a variety of applications of physics in an interesting human context.

Gross and Pizzini (1981) found that those students who had field trips showed greater achievement and positive attitude towards the environment than those who had only classroom instruction.

Kern (1985) conducted a study to determine the effect of field activities on the affective responses of the students using different approaches of teaching - one traditional and other field oriented, on-site approach. The findings revealed that field oriented approach was superior to traditional approach.

Mohanty (1973) studied the efficacy of the field trips in the teaching of social studies and her conclusion was that teachers should supplement as well as enliven the
learning experiences of students by arranging field trips as far as possible.

Lopez (1988) conducted a study to find out the field trip experiences that are possible and that are provided in the learning of chemistry. The study revealed that teaching of chemistry is very much formalized by confining it to the classroom and ill-equipped laboratory. The teachers are yet to know the latent potentials of field trips and how they can be exploited for chemistry teaching.

Ronen and Ganeil (1989) in their article discuss the potential benefits offered by a visit to a hospital, to encourage teachers to exploit this potential and to actually help them plan an effective and successful trip.

The foregoing discussion reveals that the environmental resources can be effectively utilized as a resource for physics education.

2.1.7. Teacher and in-service programme

The success of any instructional programme ultimately depends upon the class room teacher. A teacher who has not had refresher course within the past five years may flounder with the new terminology and new concept (Lee, 1967). The responsibility for helping teachers who are already on the job to meet the rapidly changing conditions of our times, to keep up with new professional developments,
and constantly to grow in competence as teachers and counsellors of young people presents a tremendous challenge. If leadership to meet this challenge is lacking, teachers will tend to go on doing much as they learned to do in the beginning. They are likely to become victims of fixed habits and to lose flexibility that is so essential to their success (Henry, 1947).

The duties of a science teacher include specifying learning objectives for a variety of content area. They must have skill in planning, managing and delivering science instruction for a broad spectrum of student abilities. Science teachers must constantly administer laboratory facilities and materials to preserve a safe environment and hands-on inquiry experiences. Teachers have traditionally relied on in-service programmes for enhancing these and other skills. In-service education is a co-operative enterprise under leadership carried on to help young teachers establish themselves in the work of the schools and to help them as they continue in their work to keep alert and growing and adaptable to such new responsibilities as may be required of them (Henry, 1947).

The Education Commission gives emphasis to the problem of giving continuous education to teachers in service. It reads: "In all the professions there is a need to provide further training and special courses of study on
a continuing basis. After initial professional preparation the need is urgent in teaching profession because of the rapid advances in all fields of knowledge and continuing evolution of Pedagogical theory and practice" (1964-'66:84).

Corey (1960) estimated the problems and issues in the field of in-service education. He emphasized planned programmes in contrast to independent attempts by teachers to improve themselves. He clearly delineated the necessity for planned programmes in in-service education for the improvement of school personnel and expressed the feeling that to depend entirely on pre-service education is impracticable.

Chaurasia (1967) emphasizes the importance of extension centers and lists some of the procedures of extension work as: (1) Experimental projects, (2) Science Clubs and Science Fairs, (3) Seminar readings, (4) Annual Conferences, (5) Training co-ordinators, (6) Intensive work with school, and (7) Assessment of Extension Centres.

According to Cottcell (1966) the major reasons for the failure of in-service education programme are: (1) Failure to recognize the real concern and problems of the faculty, (2) Inadequate supervision of the programme, (3) Poor training facilities provided, (4) Lack of knowledge about the gains, (5) Inadequate pre-publicity, and (6) Lack of Co-ordination between pre-service and in-service training.
The importance of in-service Programme to teachers was reported by Spiegel (1984). The study revealed that the group which participated in an in-service programme on student engagement rate was favoured than the other group which did not participate.

A number of research survey were conducted at different places to identify regional and state-wide categories of in-service teacher needs. They include White (1979) in South Carolina; De Graaf (1980) in Michigan; Rubba (1981) in Illinois; Zurub (1982) in Jordan; Abu Baker (1985) in Malaysia, Jbeily and Barufaldi (1985) in the Republic of Lebanon and Mecca and Klindienst (1987) in Pennsylvania. They all emphasize that accurate assessment of needs and concerns expressed by classroom teacher should precede the design of in-service education. Information on reported needs of classroom teachers should be of value to a host of state and local agencies conducting in-service courses.

The purpose of the study conducted by Chang (1983) was to determine the effect of in-service training on teacher attitudes and performance in their teaching of the new elementary science curriculum.

Molina-Mercado (1984) undertook a study to determine the relative effectiveness of videotaped, audiotaped or written transmission of the content. The study revealed that television and other media are useful as
instructional media for in-service training.

Al-Ghamdi (1984) examined the current status of in-service education of middle and secondary school teachers in Saudi Arabia and to develop a model for designing in-service education based on the findings and available literature in this field. He reported that teachers expressed dissatisfaction with the current in-service education because the programmes offered were not well planned and not based on actual needs.

The finding of the study by Matar (1986) showed that teachers attached greater importance to the areas of scientific knowledge, laboratory skills, and some aspects of delivering service instruction. The primary purpose of Caracheo's (1985) study was to integrate, from the literature on in-service education, evidence and information that can be used for developing new in-service activities and programmes and for fostering further research in this field.

Davis (1986) tried to identify factors influencing the outcomes of an in-service training project in the Kansas City school District. The findings revealed that a conceptualization of in-service training, including components for planning, implementation, and evaluation has not been sufficiently developed.
Many studies were conducted in Kerala regarding the in-service needs of teachers and the effects of in-service courses (Nair, 1963; Zalam, 1970; Kurup, 1974; Nair, 1975; Thankachy, 1984 and Jamuna, 1987). There is a near unanimous agreement that in-service training is not very effective as currently practised in educational settings and that a conceptualization of in-service training, including components for planning, implementation, and evaluation has not been sufficiently developed.

The studies reviewed above reveal that in-service education for teachers particularly those who are teaching physics is very useful in up-dating information on physics as a branch of knowledge and also for their professional improvement.

2.2 Practical Application Aspects

The basic aim of science learning in high schools must be to supply fundamental knowledge of science which may be brought into use in daily life, thus making it meaningful to the learner. Research studies have shown that if the material is meaningful to the learner, it is less easily forgotten and less easily interfered with. So it is the duty of a science teacher to attempt to make learning experiences of student as meaningful as possible through careful motivation and application to real life.
The present style of physics teaching in Kerala is criticised on the ground that the theory is usually divorced from practice and practical applications. Only in passing is well-intentional advice given concerning practical applications and activities. Practical studies are only aimed at illustrating particular theoretical propositions. This results in separation of instruction from life. To link theory and practice old methods have to be changed and instruction should acquire greater substance.

Dewey, Marx, Gandhi, Piaget, and Bruner have highlighted the importance of practical application awareness while emphasizing the importance of giving experience to students either through classroom situations or through life experience.

The importance of experience is advocated by many educational psychologists like Piaget, Bruner, Gagne and also by great philosophers like Dewey, Marx, Gandhi and all. To Dewey the philosophy of experience is peculiarly relevant. He says, "The heart of science has not in conclusions reached but in the method of observation, experimentation and mathematical reasoning by which conclusions are established. Yet in large measure, it is the conclusions that are taught in schools, with a medium of attention to the methods of controlled observation and testing, upon which the conclusion depend. So taught
'science' (1) becomes a body of ready-made truth about facts and principles, and (2) is divorced from everyday experiences of which science grows and into which it returns" (Dewey, 1938a : 480). To treat knowledge as an end in itself is equivalent to isolating it from activity. From an educational standpoint Dewey has helped us to arrive at a fruitful notion of experience and develop a working conception of it in relation to the school programme. He states: "The nature of experience can be understood only by noting that it includes an active and passive element particularly combined. On the active hand, experience is trying, a meaning which is explicit in the connected term experiment. On the passive, it is undergoing. When we experience something we act on it, we do something with it, then we suffer and undergo the consequences" (Dewey, 1902 : 156).

In Dewey's view theory without experience is not of much use. He writes, "An ounce of experience is better than a ton of theory, simply because it is only as an experience that any theory has vital and verifiable significance. An experience, a humble experience is capable of generating and carrying any amount of theory, but a theory apart from the experience cannot be definitely grasped even as a theory. A theory tends to become mere verbal formula, a set of catch words used to render thinking
or genuine theorizing, unnecessarily and impossible" (Dewey, 1938b: 113)

Marx while underlining the intellective aspect of labour has also called attention to the fact that the process of labour vanishes within the product of labour. Work loses its constructive and creative role and gets degraded. In the polytechnical education developed by Lenin, Krupskaya and others, material production is closely woven with the production of ideas, conception and consciousness (Manuel, 1987). Krupskaya (1985) holds the view that modern production is based on the application of the laws of scientific knowledge of nature, society and production. All these must be conveyed to pupils by acquainting them in both theory and practice and by making them participate directly. Such a general basis will then make it easier for students to master any skill.

Piaget's theory of cognitive development has had a considerable influence on our thinking about education of young children for many years. His insistence on the importance of experience involving direct action upon objects as a necessary precursor to concept formation has lent support to those who advocate an activity based environment for children. His theory has been considered to have a particular application to the way we structure learning in certain areas of curriculum. The most immediate
and obvious relevance has been to teaching in mathematics and science because so much of Piaget's work involved scientific concepts and the link between theory and practice is therefore most evident in those areas.

The extrapolation to classroom activities of Piagetian theory of intellectual development suggests a way of teaching science which is in agreement with the philosophers of the newer science curricula and it also suggests a method for practising the skills. As viewed by Piaget, knowledge is the result of an active interaction between a learner and his environment and he stresses the necessity of direct experience along with mentally active learner.

According to Bruner (1960) who has attempted to extend Piaget's theories to classroom work, there are three modes of instruction which keep children mentally active. The inactive mode allows students to manipulate the actual objects of knowledge and is appropriate for children in the concrete stage of intellectual development. The iconic mode permits children to manipulate pictures of actual objects and is appropriate for children making the transition from the concrete to formal stage of intellectual development. The highest mode called symbolic, involves working with symbols of objects and is appropriate for students using or developing formal operations. The amount of time spent in
each mode of instruction depends on the maturity, past experience and cognitive level of the learner. In any event, the pre-requisite for symbolic manipulation is experiences in the inactive and iconic modes of instruction.

Applying the above ideas to classroom, the science laboratory permits direct experience with the objects of knowledge, while ensuring discussion allows work with iconic and symbolic representations, namely, pictures or models of experiments and words which describe, analyse and verify the objects of knowledge. But both the discussion and laboratory activities are important.

Emphasising the importance of practical application in science teaching the Secondary Education Commission (1952-53) observed that the aim of science teaching was to awaken in the pupils a lively curiosity about the natural phenomena around them and to develop the capacity for the practical application of their knowledge. So formulating 'general courses' with emphasis on practical applications and observations is a need of this century. This clearly establishes a need for developing practical application awareness among the secondary school pupils.

If pupils are to have the breath of view needed to tackle the problems arising from the application of science to their everyday lives, they should be equipped to do so through science teaching. Practical application awareness
should be provided a larger and more explicit place among the goals of science education. When unrelated to practical applications science education becomes purely speculative and knowledge itself becomes formal.

Physics is indeed the disciplinary medium through which one learns and teaches many of the most fundamental concepts of natural processes. In the words of Heller, "Although physics deals with the pupils' own world of moving objects, rotating wheels, electrical currents and weights and measures, the usual approach to these topics too often appears trivial and separated from 'real' issues, or too difficult because of the mathematics involved (1972 : 214). Newbury and Armstrong (1962) believe that physical science using simple, familiar equipments, often obtained from home or junk shop, has advantages no other subject possesses. A student cannot only guess or hear from someone, that a magnet will lift a coir or a nail, but he can immediately carry out tests for himself and verify if the guess, or his information is correct. He can refine his knowledge by finding out which metals are actually attracted by a magnet and which are not. This immediate and tangible proof is a source of great excitement and satisfaction to children.

The recent trends in science teaching has shown a distinct tendency of general change in emphasis from mere
acquisition of assorted facts to the development of functional learning, from unrelated knowledge units to contents logically organised about problems that concern the pupils. Craig (1966) believes that the content taught is not of nearly so great importance as it is the question of 'What' science content is taught, 'how' it is taught and the 'purpose' for which it is taught.

One of the best measures of a student's mastery of an understanding is the ability to apply the principles in new situations. Ralya (1938) found that pupils often could recall the formulae and work out answers to problems and still not understand the principles involved. The importance of emphasizing applications of Physics in everyday life in the physics curriculum has been stressed by many authors. (Godman and Hobson, 1963; Schmidt and Rockcastle, 1968). A credible science methods instructor according to Shringley (1976) is one who refers to practical teaching activities in class.

Students know best about those things with which they have direct experience and know least about those things which they have memorized. Science classes in primary and secondary should consist of hand-on experiences with science materials which could function at the students' cognitive level of development. According to Wavering
(1982) the teacher should provide examples and suggest experience-broading activities. Teachers at all levels should make learning experiences as close to life situations as possible so that students can understand the uses of scientific processes and the overlap of science with society.

Many studies conducted in India throw more light on the fact that most of the students achieve only knowledge of the content matter presented to them (Knowledge of facts, principles, concepts, etc.). Thomas (1971) tries to find out how pupils fare in the higher levels of knowledge as well as in lower ones. His findings revealed that students' achievement in all the other five areas of cognitive domain except that of knowledge area, were far from satisfactory. The same was the outcome of the study conducted by Swarnamma (1967).

Driver (1988) points out that teaching programmes are being developed, for example, which present science principles in contexts which are in themselves seen to be of practical use.

Positive student attitudes concerning science classes and teachers are reported by Brunkhorst (1987) and Yager (1988). School students feel the science they study is useful and that it will be even more useful in the future. The study by Yager, et al. (1989) reveals that students who
practice the use of science perhaps have more accurate and realistic perceptions of its usefulness over students who are recipients of science information in typical science classrooms.

Students experience difficulty in translating the theoretical knowledge in science they gain through classroom instruction in other practical situations and their awareness in practical application oriented aspects are not satisfactory. This has been the outcome of many research studies (Jaya, 1985; Sreedevi, 1985; Rema, 1987; Suma, 1987; Usha, 1987; Nair, 1988 and Vasanthakumaran, 1988).

A comparison of students' applied and theoretical knowledge of concepts based on the particulate nature of matter was attempted by Haidar (1988). A Two-Form instrument, called the Physical Changes Concept Test (PCCT) was developed for the study. The Application Form measured students' knowledge using everyday language. The Theoretical Form measured students' knowledge using scientific Language. The analysis revealed a significant difference between students' applied theoretical knowledge.

The above discussion points out among other things that the pupils' awareness of practical applications of the theory they have learned is not satisfactory when compared to their theoretical knowledge.
2.3 Intelligence, Socio-Economic Status, etc., and Academic Achievement

The constructs of variables of the study related to student achievements namely intelligence, socio-economic status, sex, locality and management of school are sufficiently common place and so only research studies conducted in these areas are reviewed in the ongoing discussion.

2.3.1 Socio-economic status and achievement

Good defines socio-economic status as "the level indicative of both the social and economic achievement of individuals or group" (Good, 1945: 222). Usually the educational level, occupation and income are considered as the major components of this concept. One important factor affecting the education of the child is the level of education of the parents. Generally the educated as well as the high income groups encourage children in studies. Studies have revealed both positive and negative influences of socio-economic status when components like education and occupation of parents are taken separately.

The performance in education is a positive function of the socio-economic status of the student and his parents has been the conclusion of a number of research studies (Mathur, 1963; Warrior, 1966; Abraham, 1969; Joseph,

Chopra (1964) conducted a study to examine the relationship between socio-economic factors and achievement keeping the effect of intelligence constant. His findings reveal that on the basis of parents' education, occupation, family income, type of lodging, size of family, cultural level of home, students belonging to higher qualitative group show significantly higher achievement.

Anand (1973) established relationship between socio-economic status and academic achievement even when the influence of intelligence of nonverbal and verbal type was partialled out.

Recent studies by Khanna (1980); Panchamukhi (1981); Jayannadhan (1986) and Yadav (1988) have shown positive and significant influence of socio-economic status on student achievement.

Studies conducted abroad by Jenecks, et al. (1972) and Bronfebrenner (1974) have also shown the influence of socio-economic status on achievement when factors like education, occupation and income of parents are taken and studied separately.

Marjoribanks (1983) investigated the relations between occupational status, family learning environment and
childrens' academic achievement. His findings reveal that parents' occupational status is related to childrens' school achievement.

Arochova and others (1984) investigated a selected sample of low-middle status urban children over two life decades and correlated the data of their scholastic achievement with family's status. The result showed that socio-economic status and achievement are related.

Although a number of research studies have established positive relationship between socio-economic status and academic achievement, there are certain parallel studies by Srivastava (1967); Reddy (1973); Sudama (1973); Ahluwalia and Syam (1975); Salunke (1979) and Sharma and Bhargava (1980) which did not find any significant relationship between socio-economic status and student achievement.

A recent study conducted by Anand (1989) also reveals that students' academic achievement and their parental educational and occupational status have been significantly correlated and inter-linked. Ganguly (1989) also found a significant correlation between socio-economic status and academic achievement.

In general the socio-economic status appears to correlate positively with academic achievement even though there are studies showing very little or negligible influence.
2.3.2 Intelligence and academic achievement

The fact that intelligence correlates with academic achievement is an unquestioned one. When schools are considered as units, rather than individual children, it is still found that the greatest single factor determining the level of attainment is intelligence. More than half the variance in attainment in reading, problem arithmetic and general information is accounted by this factor (Kemp, 1964).

There are enough evidences for a consistent dependable relationship between school achievement and intelligence. Correlation between the two varies from study to study, but the bulk of them range between coefficient 0.30 and 0.80 (Thorndike and Hagen, 1961).

A summary of 24 Studies was reported by Sadie (1949) in which a measure of intelligence was found to be related to general high school achievement.

Kapur (1961); Duwayne and Vinton (1964); Payne and Pyier (1965); Sinha (1967); Gupta (1968) and Nair (1970) also examined the relationship between intelligence and achievement and all of them obtained positive and significant relationship between the two factors and in certain cases the relationship was found to be very high.

Between 1970 and 1980 many more research studies were conducted in this area and the findings confirm the

More recent studies conducted by Shivapa (1980); Srivastava (1980); Marek (1981); Shashidar (1981) and Singh (1981) also report positive and significant relationship between intelligence and academic achievement.

In a differential study conducted by Patil (1983), the correlation between intelligence and achievement was 0.28 after partialling out interest and aptitude factors and she concludes that intelligence seems to be positively and significantly correlated with achievement.

Lata (1986) examined the relationship of cognitive style with scholastic achievement and intelligence. The findings of the study revealed a significant high relationship between intelligence and scholastic achievement and arrived at the conclusion that intelligence scores are quite an accurate predictor of academic achievement.

In short there seems to be certain relationship between intelligence and student achievement.

2.3.3 Sex differences and academic achievement

Sex differences in school achievement has been a fertile area of study by early differential psychologists.
These studies possibly originated from the fact that sex differences were noticed in many of the ability dimensions like intelligence, differential aptitudes, and as such, researchers expected a corresponding differential in the variables like school performance which are dependent on the activities.

A study by Jordan (1956) on North Carolina High School seniors revealed that the critical ratio of the differences was in favour of boys for science sections of the achievement test employed.

Edgerton and Brills (1944) found that in science talent search, boys scored higher than girls. Learned and Wood (1938) reported that the mean achievement scores in natural science was higher for males. But Prunett's (1961) study revealed that girls did better than boys in mathematics achievement.

Flanagan, et al. (1964) reported the superiority of boys in mathematics and science. Wisenthal (1965) found significant differences in achievement in favour of girls. George and Abraham (1967) compared the performance of boys and girls and reported a significant difference in favour of boys for general science and general mathematics. Nair (1968) also found significant differences in favour of boys for different achievement measures used in his study.
Anderson, et al. (1968) found boys scoring more in high school science. Nair and Ramachandran (1968) also reported sex difference in science aptitude, the mean score favouring boys.

Powel et al. (1963) found no significant difference between sexes for many of the achievement areas while Pillai's study (1969) revealed that sex differences exists in all areas allied to science achievements.

Parsley et al. (1964); Paul and Rao (1969) and Fernandez (1969) reported that performance of boys were better than girls.

The studies conducted by Keeves (1978); Murphy (1978) and Harvey (1980) found that boys perform better than girls in science.

Andrew (1980) found that girls are superior to boys in skills in scientific process. Howe (1981) conducted an investigation into sex-related differences on a task of volume and density, and a difference favouring boys was reported.

Butt (1981) reported that at the collegiate level there is no considerable difference between educational performance of girls and boys. Erickson and Erickson (1984) reported males are superior to females in academic achievement at the secondary school level.
Randolf (1984) studied eighth Graders and concluded that there is no significant difference between the performance of boys and girls.

Zerega and others (1986) reported significant difference favouring boys in science achievement.

Goldstein (1986) reported that although males demonstrated significantly greater special ability than females, there were fewer significant differences in their science achievements. Ekeocha's (1986) study revealed that males sufficiently outscored the females in physical science.

The study conducted by Haynes et al. (1988) examined the differences between high, average and low achieving Black male and female high school students on measures of learning and study behaviour. The results indicated significant differences between male and female students on measures of learning and study behaviour.

2.3.4 Locality of school and academic achievement

The school environment can influence the student achievement, motivation, attitudes, etc. The facilities available for physics teaching in urban and rural schools may differ. There is a belief that urban schools have better educational resources than rural schools. The effective utilization of educational resources may influence the
students' achievement in this context the locality of the school whether it belongs to urban or rural are a is to be considered while evaluating the students' performance.

Studies comparing the performance of urban and rural schools are scarce. But differences in the achievement of students from urban and rural areas are reported by many researchers. Considering the fact that most of the urban pupils study in urban schools and rural pupils in rural schools, some studies relating to this theme are presented below.

Sheppard (1942) found that rural children were inferior to their urban counterparts in verbal tests. Studies conducted by Lehmann (1959) and Barr (1959) revealed that rural children, as a group were inferior in general ability to urban children.

Saxena (1963) compared the achievement of urban and rural students in science. He reported a significant difference in the average performance of boys of urban and rural schools, the difference being in favour of urban boys.

Studies conducted by Pavithran and Feroz (1965); Thomas (1965); Warrior (1966) and Vernon (1964) revealed that urban pupils were superior to rural pupils in their academic achievement.

Nair and Visweswaran (1966) conducted a study to compare the achievement in general science of urban and
rural pupils of Coimbatore district and no statistically significant difference was found between urban and rural students. The findings of the studies conducted by Mathew (1984); Paul (1984); and Nair (1988) also revealed that there was no significant difference between urban and rural subjects in academic achievement.

The findings of the studies by Suma (1987) and Vasanthakumaran (1988) revealed that urban subjects were slightly better than rural subjects in academic achievement though not statistically significant.

From the above discussion it is evident that the locality of school is one of the factors that affect the academic achievement of students.

2.3.5 Management of school and academic achievement

School achievement is the outcome of the combined efforts of teachers, students as well as the types of school. The latter refers to the type of school management, that is, whether managed by a private organisation or a trust known as private school or managed by a local government, known as government school.

It is generally assumed that private schools offer better education than government schools. So research studies were conducted to compare the quality of education (in terms of academic achievements of students) between
these two types of schools.

There are not many studies comparing the performance of private and government managed schools. The few studies carried out on this subject are unequivocal in their conclusions. There are few studies conducted by Abraham (1974); Dhami (1974); Anwar (1980); Sujatha and Yeshodara (1986) where type of management of school had been studied as one of the variables. These studies have made comparisons in terms of a few educational variables like academic achievement, personality factors and so on. The findings of these studies have been inconsistent.

The outcome of the study conducted by Sengupta and Veeraraghavan (1985) was that academic achievement of students is a function of achievement motivation and types of schools where they study.

Veeraraghavan and others (1989) conducted a study on school achievement and student motivation in different types schools namely government schools, private schools and missionary schools. The findings revealed that school achievement varied significantly in terms of the type of schools and in favour of private schools.

Petrella (1986) reported significant difference between public and private schools in all areas of the study except academic requirements and teacher misassignment.

A comparative study of some educational variables
of students of private and government schools was conducted by Reddy (1990). The analysis of results revealed that academic achievement of students studying in the private schools was significantly lower than that of students from government school. She attributed this to the lower levels of facilities available in the private schools.

Eventhough the studies reviewed in this area are limited, it points out that the type of management of the school can influence students' achievement.