CHAPTER II

REVIEW OF RELATED LITERATURE

CHAPTER II

REVIEW OF RELATED LITERATURE

2.0. Chapter Preview

The investigator makes an attempt to present a brief review of the relevant literature on the status of the work-oriented and industry-based learning at different levels of education. She also reviews the studies related to the use of outdoor learning resources for learning various academic subjects. The chapter is closed with the major outcomes of the review which converge towards the need and relevance of the present research attempt.

2.1. Introduction

A careful review of research journals, books, dissertations, thesis and other sources of information on the problem to be investigated is one of the important steps in the planning of any research study. Since effective research is based upon past knowledge, this helps to eliminate duplication of what has been done and provides useful hypotheses for investigation. The review of the literature is a valuable guide in defining the problem, recognizing its significance, suggesting promising data gathering devices, appropriate study design for the sources of data.

Education is found essential for preparing and training manpower to manage capital, technology, services and administration in all sectors of economy. In its 'Sector Policy Paper', the World Bank stresses

that education meets a basic human need by providing a broad basis of knowledge, attitudes, values and skills, on which to build a later life (UNESCO, 1987). Scientific inquiry stands for a systematic and investigative performance ability which incorporates unrestrained inductive thinking capabilities after a person has acquired a broad and critical knowledge of the particular after thorough formal learning process. All these views indicate the need for a science and technology training which provides knowledge, skills, attitudes and values.

An explicit pedagogical focus on the learning process advances the learner's conceptions of learning, improves what they learn and increases the likelihood that they will see themselves as active agents in learning (Pramling, 1990). Increasingly, transferable generic skills – which it is expected will be required for future employment – are being specified as learning objectives. For instance, adaptability, creativity, communication and social skills, problem solving, organization, time management, being able to work independently, metacognition and the use of information technology are being identified as important as are personal competencies which develop citizenship (Bayliss, 1998). Such educational aims are important for developing the motivation and skills required for learning through life and are likely to become more important in the future.

2.2. Metacognition for effective learning

Metacognition is a generic term which refers to a second-order form of thinking: thinking about learning. It includes a variety of self-awareness processes to help plan, monitor, orchestrate and control

one's own learning. An essential aspect of metacognition is that learners monitor or regulate their own learning and that self-assessment or self-evaluation is crucial component of learning. Such learners monitor their learning using particular strategies which hinge on self-questioning in order to get the purpose of learning clear, searching for connections and conflicts with what is already known, and judging whether understanding of the material in sufficient for the task.

Research indicates that good learners tend to have good metacognitive strategies (Bruner, 1996). If pupils are to become competent assessors of their own work then they need sustained experience in ways of questioning and improving the quality of their work, and supported experience in self-assessment which includes understanding what counts as the expected standard as well as the criteria on which they will be assessed (Sadler, 1989). Recent research on the brain and learning (Hart, 1983; Jensen 1994; Sylvester, 1995) also confirms the importance of metacognition

As the goals of education begin to change to reflect new social and educational needs, teaching strategies also change and so, consequently, do strategies for integrating technology into teaching and learning (Roblyer etal, 1997). Education should emphasize more general capabilities for "learning to learn" that will help future citizens to cope with inevitable changes. For example, instead of learning specific items of information, they want to emphasize training in ways of acquiring, sorting through, and using information.

The types of teaching strategies that have been suggested by various researchers (Nicholls, 2004; Ames, 1992; Watson, 1990) as facilitating conceptual change and helping pupils think about their learning include:

- Providing opportunities for pupils to express clearly their own conceptions about the topic so that they can be examined in detail;
- Presenting examples that challenge children's prior ideas;
- Using strategies that enable pupils to consider and evaluate alternative conceptions of presented phenomena;
- Providing opportunities to use new conceptions. Long-term accommodation of a person's conceptions is not likely to happen if new schemas are not seen as useful;
- Giving pupils opportunities to become aware of their own conceptions and how they change

Jolliffe & Stevens (2003) found that learning needs to focus on problem-based scenarios, project based learning, team-based learning, simulations and the use of technology resources. Many studies revealed that the new ways of thinking about things lead us to the production of new ideas and new inventions.

Studies have demonstrated that effective learners may be proactive in their metacognitions – their thinking about their thinking – and their own process of learning. These effective learners may have a more fluent understanding of their own learning than others and may possess the ability to 'talk themselves through' difficulties which arise. Knowledge about the promotion of such effective learning has been described in relation to four

themes: active learning, collaborative learning, leaner responsibility, and meta-learning or learning about learning (Watkins et al., 1996).

Reflection is an active and deliberate cognitive process based on well sequenced and interconnected ideas, supported by beliefs, knowledge and experiences. The teaching/learning at the reflective level involves careful and critical examination of an idea or problem in the light of the empirical or testable evidence that supports it and the further conclusions towards which it points. The goal of education is to foster intelligence and reflective teaching/learning should be the core approach used by teachers everywhere.

Mason (1992) conducted a study on the use of concept mapping as a tool to develop reflective science instruction. The results showed that concept mapping is an effective tool on conceptual restructuring and encouraging reflective science learning and teaching. Mason (1992)also stressed the importance of concept mapping in learning physical sciences. He showed the relationship between concept mapping and other variables such as achievement, cognitive ability and attitude towards science. Studies reveal that concept mapping can be used as a basis for developing lesson plans, for problem solving and on the development of science process skills.

Duchovic (1998) in his study discussed two techniques, which have been utilized for five semesters in general chemistry courses and which attempt to surmount barriers to learning by emphasizing the conceptual framework of the science of chemistry. One of these techniques is the use of a repackage system for all other examinations during the term, while the second engages students in writing exercises based on laboratory

portion of the course. Both the techniques were found to be equally effective for learning

2.3. A Focus on the contexts of teaching / learning

Knowledge, if it is to be useful, must be inextricably linked with activities and situations. It must evolve in contexts of new use, new situations, and new activities; it must be in continual construction. 'Meaning makes learning easier, because the learner knows where to put things in her mental framework, and meaning makes knowledge useful because likely purposes and applications are already part of the understanding, (Shepard, 1992). Experienced teachers view their educational purpose as increasing the quality of students' thinking, engaging them in the processes of learning, and improving their disposition towards learning (Copeland et al., 1994). Learning activities are constructed from the key elements (Doyle, 1984) as shown in figure. 2.1.
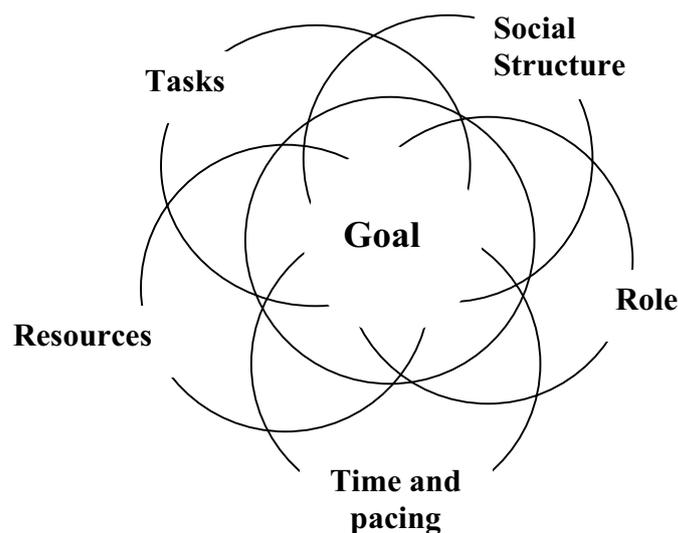

Figure: 2.1. **Elements in teaching activities**

Merickel (1998) gave a comparison of teaching models emphasizing their characteristics on the basis of elements of teaching, as shown in Table 2.1.

Table 2.1

A comparison of teaching models by Merickel (1998)

Elements of Teaching	Traditional Teaching	Contextual teaching
Source of Information	One-way. From teacher to student, or text to student	Complex, Individual search, discovery and reflection. Social interactions. Thematic and real world subject matter.
Classroom Organisation	Linear. Individual work or teacher directed	Complex. Thematic, cooperative, real world workstations, apprenticeships and internship
Classroom Management	Hierarchical. Teacher Controlled	Complex. Designated status and responsibilities delegated to students and monitored by teacher
Outcomes	Specified and convergent. Emphasis on memorization, Vocabulary and skills	Complex. Emphasis on organization of information in unique ways, which present real world problems. Both predictable and unpredictable outcomes. Outcomes should be both divergent and convergent. Demonstrates meaning through the ability to use learned skills in various contexts.

He concludes by commenting that a teacher must not forget that much of what happens in the school must be in the context of the larger society (e.g. the work place).

Teaching and learning are most effective where they are 'constructively aligned' with assessment procedures (Biggs, 1996). Learning has a range of outcomes, qualitative, quantitative and affective, which may or may not be formally assessed, which nevertheless through the process of 'backwash' affect future learning (Biggs and Moore, 1993).

Another research stresses the need for children to be provided with a supportive but challenging multi-sensory environment in which they are given regular educative feedback and opportunities to review what they have learnt as well as opportunities to learn about, improve and extend, their current learning strategies (Smith, 1998).

Adamson (1992) developed a Contextual learning model and proposed four level changes in approach to chemistry education from his experiences with the following illustrations.

1.   More emphasis on using the experiences that student brings to the classes, which can be done in two ways

    (i)   Teach the chemical concepts, feed in the relevant examples and contexts relating to students' experiences.

    (ii)   Start with student's own experiences and deep-feed the chemical concepts on; need to know' basis.   Teach the

students when they are in a set to make use of a particular experience or context for furthering their existing knowledge.

2. More emphasis on social, industrial, economic environmental and technological issues, where 'chemistry in action' package is a valuable resource.

3. A wider variety of teaching and learning experiences to develop skills which involve role-play, computer, video etc. (for the mastery of the teacher)

4. A greater involvement in the assessment of students, which involves not only the unit tests but assessment of skills, abilities, values etc.

One of the most fundamental problems which pupils have in learning is that of transfer: the transfer of knowledge between domains and/ or contexts. If the concepts or generalizations (meanings) gained in one learning situation are applicable to the new situation, they may be used in the process of solving the new problems. This does not result automatically or even building up the 'habit' of thinking but rather by continuous enrichment of concepts. The richer the concepts or meanings, the greater is the likelihood that the old and the new situations will have common elements and hence that transfer will take place.

2.4.   Learning outside the classroom

The significance of learning outside the classroom has been emphasized in a good number of studies. Learning by doing and learning

by living are the two cardinal principles of teaching and the same is truer in the learning of science. Science teaching in our classrooms is mostly rigid and verbal and, therefore, quite uninteresting. It is conducted predominantly in three types of learning environment – Classroom, Laboratory, and Outdoors. The outdoor is the one most neglected by teachers, curriculum developers and researchers (Orion & Hopstein, 1994).

Even though suitable outdoor sources are available to learn science through concrete first-hand experiences and situations or through discovery method, students are generally forced to memorize unrelated facts and principles without understanding the meaning of terms, concepts and their practical implications (Driver, 1989; Selberg, 1972; Wellington, 1981)

Resnick (1987) has offered a useful analysis of the differences (which pupils might come across or) expected of learners in and out of school. She has identified three major differences. These are summarized below:

In School	**Out of school**
Individual cognition	Shared cognition
pure mental activity	Use of cognitive tools
generalized learning	Situation – specific competence

Resnick (1987) argues, "Out of school, because pupils are continuously engaged with objects and situations that make sense to them, people do not fall into the trap of forgetting what their calculation or

reasoning is about objects and things. Actions are grounded in the logic of immediate situations. In school, however, symbolic activities tend to become detached from any meaning for context.

In order to achieve life-oriented educational aims, apart from classroom teaching, the out-of-classroom resources like the Small Scale Industries (SSI) can contribute a lot to the students' learning. Thereby a mutual relationship may contribute to national wealth. This view is substantiated by the findings of the studies conducted by Savadamuthu (1989), Sree Kumar (1992), Grace 1994) and Jayaraj (1997)

Appropriate combination of knowledge and skills needed to apply technology, can result ultimately in a high level of productivity and production (Devadas, 1999)

For an effective programme of science, adequate teaching materials are also essential. Community resources that are suitable for the purposes should be made available and should be used when needed. The learning environment should extend beyond the classroom. Students know a great deed about the world and they learn best when what they learn connects with the world they know. Therefore the redesigned learning environment includes links to the community and the workplace to help develop student's abilities to solve problems and communicate effectively the kinds of skills they will need when they enter the workforce.

Out-of-classroom activities as learning experiences have been the subject of study for many researchers like Ebel (1969), Myers and Lee

(1980), Crompton and Sellar (1981), Meyer and Rao (1984), Santos (1988), Miller (1988), Han Eun Sok (1991), Swafford (1995) and John (2000). A few studies which are representative in this context are discussed below:

A study by Joseph (1976) explored in detail the potential and practices of using school resources in conducting science clubs. The study found that resources like fields, agricultural farmers and garden are present near almost all schools. But only a small number of teachers use these environmental resources for teaching science.

John (2000) developed a Guided-Field Study Model (GFSM) and tested its effectiveness by comparing the achievement in Ecology of the treatment groups viz., Guided-Field-Study Method (GFSM) group, Lecture Method (LM) group and Self-Study Method Group (SSM). The findings of the study led to the conclusion that Guided Field Study Method is superior to Lecture Method with regard to Post-rest achievement. The study also showed that resource units based on GFS models are a necessity in higher secondary schools to help teachers realize the possibilities and potentialities of guided field study method.

Swafford (1995) made a survey to determine the perceptions of outdoor educational professionals concerning the best methods, strategies, materials and resources for elementary teachers to use in developing an outdoor laboratory for their school. He designed an outdoor laboratory based on the significant activities by the participants.

The ability of young learners to acquire scientific concepts in informal learning institutions such as museums, zoos, aquaria and science centres is enhanced by using authentic investigative methods similar to those employed by scientists. This is the finding of Arenson (1996) from using the Zoo Reach Program. He proposes the program as an effective model for further development of informal learning techniques. The program includes teaching, training, curriculum materials, and hands on objects used while touring the facility.

2.4.1. Curricular Potentials of Out-of-Classroom Resources for Learning Academic Subjects

In order to achieve life-oriented educational aims, apart from classroom teaching, the resources available outside the classrooms should also be identified, explored and utilized, so as to make the education more productive and meaningful to the learner. There is no scarcity of resources in India and our country is pregnant with unlimited natural resources, which an educated man can use and develop, so as to make his life worth living, and to increase the nation's productivity. This can be achieved only through science education coupled with occupational training. To give the common man an insight through education and for linking education with occupations, a well balanced, scientifically based and practical-oriented curriculum utilizing the out-of-classroom local resources is highly essential.

A closer analysis of the review of the related literature shows that not much has been done in India and abroad in the area under investigation. However, the investigator could come across a few studies relating to out-

of-classroom resources such as local occupations (Susan, 1990, Geethalekshmi, 1994; Grubb1995a, 1995b; Gaskell & Hepburn, 1997; Raughton, 1997; Krishnankutty, 1998; and Perin, 1998), agriculture and related activities (Lelitha, 1984; Scaria, 1984; Sulochana, 1984; Sreekumar, 1992; and Binu, 1997), Livestock Management (Philip, 1992, and Bindu, 1995) industrial operations (Savadamuthu, 1989; Grace, 1994 and Jayaraj, 1997), field trips (Kasi Viswanathan, 1997) and Fishery and related activities (Abraham, 1997 and Binumon, 2000). An attempt is made here to give a brief description of a few representative studies in the area under discussion.

Gaskell and Hepburn (1997) observe that the present day schools are not preparing students appropriately for the changing technological requirements and increased worker responsibilities that are the product of industrial restructuring. They have put forward the following suggestions to improve the school-to-work system.

1.   the integration of academic and occupational curricula.

2.   the linking of school with structured work experience and

3.   the criterion of formal connection between secondary and post-secondary education.

Susan (1990) discussed about the hidden curriculum in agro-based occupations. In an earlier study (Susan, 1983), she highlighted the importance of sports and games as a very powerful out-of-classroom resource for integrated learning of academic subjects and development of skills associated with occupation. She also developed some models for maximizing academic achievement through the medium of sports and games.

Sulochana (1984) made an attempt to prepare certain instructional models based on farming for the learning of science in high school classes. The models prepared were found to be good for learning Biology through the medium of farming.

Grace (1994) analysed the curricular potentials of twenty one small scale industries for learning of physics and to find out the feasibility of utilization of these potentials at secondary and higher secondary stages of education. All the 21 industrial activities were found endowed with extensive curriculum potentials for the learning of physics at secondary and higher secondary level.

Kasiviswanathan (1997) made a study on "History of curricular potentials of certain Monuments in Tamil Nadu". He found from the study that all categories of personnel viz., students, teachers, Head of Institutions, parents and officers of monuments, in general, are for the students, serving as tourist guides of monuments. The officers, in general, are found prepared to pay pocket expenses for student tourist guides, besides preparedness to give them preference in the recruitment of employees for monuments. Neither sex nor co-education system is found to be a barrier in making study visits to monuments.

Jayaraj (1997) carried out a study to analyse the chemistry curricular potentials of 45 chemical-based industries. The content analysis of the industries in terms of the objectives which could be realized through the content and the findings revealed that all the industries possess potential for learning chemistry at the undergraduate level.

Sreekumar (1992) analysed the Biology curricular potentials of 12 small scale agro-based industries of Kanyakumari district, Tamil Nadu in order to find out their curricular potentials for teaching Biology at secondary and higher secondary stages. The major findings of the study were that 18 kinds of small-scale industries studied were found to be possessing extensive curricular potentials for learning Biology at secondary and higher secondary levels.

A study conducted by Valsala (2002) on the environmental education potential of botanic gardens revealed the effectiveness of using botanic gardens for school level learning of biology. The study identified the resources and facilities in botanic garden for environmental education. It concluded that botanic gardens can be considered as a learning resource centre with live examples and as an exploratory centre of all types of plants.

Savadamuthu (1989) studied the curricular potentials of 17 kinds of chemical-based small-scale industries for chemistry learning at secondary and higher secondary stages of education. The study revealed that all the 17 kinds of industries are endowed with extensive potentialities for learning chemistry at secondary and higher secondary levels of education for learning chemistry at secondary and higher secondary levels of education.

The studies reviewed above strongly support the contention that out-of-classroom resources have immense potentials for learning academic subjects.

2.5. Apprenticeship System

Apprenticeship or training under guild organizations originated during ancient times and continued during the middle ages, was

among the first from the organized learning to increase man's efficiency in work. Through the ages, however, there has been but one way for the unskilled worker to learn to do his work, namely, the "pick up" method, in which observation, imitation and individual initiative constitute the sole means of training. The age-old method of learning on-the-job with no or little assistance and supervision is the unorganized form. It is only in recent years (decades) that any serious attention is given to the training of unskilled worker to do his tasks efficiently.

In pre-industrial societies, occupational skills were learnt through apprenticeship within the home or through a system organized by trade and craft guilds. Education was neither necessary nor relevant to the practice of most occupations. In modern industrial societies, most occupations require formal training which is itself based upon a certain minimum of book learning. Higher positions in any occupation or industry generally require a greater amount of book learning. Education is thus an important condition for obtaining occupational opportunity. Generally industrial societies are occupationally and socially more mobile than pre-industrial societies.

Modelling is the basis of apprenticeship, leading the novice into the skilled ways of the expert. An underlying assumption is that the less skilled can be taught by showing, and that they have the ability to learn through imitation. Studies of expertise demonstrate that just learning how to perform skillfully does not get one to the sake level of flexible skill as when one learns by a combination of practice and conceptual explanation.

Apprenticeship system provided vocational education in ancient and medieval times. In ancient India, vocation was on family basis, the son learned the vocation by working with the father. In carpentry, in the field of ayurvedic medicine, in farming etc. this was the practice. Knowledge was transferred from one generation to other without commendable change, unless people deliberately tried to bring forth transformations. The main focus of knowledge transmission was training through prolonged practice rather than acquiring a sound knowledge base. Even now the apprenticeship aims at making pupil practise what they have already learned. There are little chances to reflect on their learning during the course of study and also during the training period.

The unprecedented developments in science and technology have tended to expand vocational areas for which organized education or training is required. The origin of vocational education may be traced to the early apprenticeship training practices. Vocationalisation of education is getting more prominence in these days as the technological advancement demands more trained people in various vocations. The job opportunity pattern is also changing even in industries. There is no way of knowing directly the quality of students turned out and also there is no feedback system which may indicate the type of product being produced as well as the product wanted in the industry/field. Those who will become labourers in industry and agriculture need a command of basic knowledge of elements and compounds and some practical skills in working with them.

Learning on the job is viewed as on ongoing way of life which is challenging, exciting and personally constructive (Aldrich, 1999).

Learning on the job offers a rich environment for generating diversity and change. Each and every experience will help pupils to construct personal meanings, made up of thoughts and feelings which underlie all their anticipations and actions.

Learning in work-related contexts is a collaborative process leading to highly context-specific forms of reasoning and skills (Resnick, 1987). It is multi-functional and can provide students with an opportunity

1) To enhance the links between their programmes of formal education and training – either in vocational education and training or in general education – and real work contexts,

2) To acquire occupationally-specific skills, economic and industrial awareness and the development of generic competences and skills and

3) To become lifelong learners through broadening the basis of their experience.

Building the theoretical bases for learning in work-based contexts and defining the pedagogic approach to such forms of learning work around the idea of experiential learning (Resnick, 1987). The philosophy of experiential learning has been widely endorsed in the literature on learning in work-based contexts. The different traditions of learning in work-based contexts have all tended to see experience as the key source of learning. Further, experience has also been seen as the central means by which students acquire worthwhile knowledge and skill about the world of work. From this perspective, knowledge of the world of work is deemed possible because it is assumed that there is a direct correspondence between the world and the way it is represented in the student's experience.

Within recent years, the progress of science and technology has called increasingly for the systematic organized training of skilled personnel to man great numbers of new jobs and many old jobs with profoundly modified process. Operations once performed manually are now largely performed through machines. Thus the emphasis in training is shifting from the acquisition of technical knowledge intelligently on the job or the activities associated with it. <u>This fact has led to the central idea of organizing education systematically and efficiently through the establishment of vocational institutions and modernized training at work places.</u>

2.6. Industry-Oriented Learning

Research has shown that a visit to an outside learning environment (a museum, industry, botanic garden etc.) that has a proper purpose and is planned has a very positive influence on the opinions of students (Key, 1998). As successful visit requires effort at the planning and execution stages. To justify this effort, both the learning centre and school need to aim to generate as many positive outcomes as possible through the visit. Students can be released from school to experience an industrial placement. The main reason for these visits is to emphasize to students how science is applied in industry.

The benefits of a site visit include

- Providing a context for learning in the classroom;
- Contributing to an improved scientific and technological literacy in society

- Helping to inform young people of the career opportunities in industry; and

- how industries are responding to issues such as environmental preservation and sustainable development

A study conducted by Parvin & Stephenson (1999) showed how industrial sites can be used for learning science. The study revealed that the visit to an industry will provide students a more accurate awareness of industry in the following areas:

- Raw materials used;

- Processes involved, and the number of processes per site;

- Equipment used to carry out processes;

- General appearance of a chemical site;

- Working environment;

- Range of jobs carried out and their desirability, especially those requiring scientific and technical knowledge.

- Industry's involvement in scientific research ('testing').

A preliminary visit to the industry before taking school students for site visit is, however, very desirable. It helps the teacher to identify and locate ideas regarding:

» Objectives of the visit

» How the visit links with the curriculum, classroom work, and experience before and after the visit.

» Students' knowledge and level of understanding in science.

49

» Appropriate language to use with the students.

» The structure of the visit, site route and timings.

» Description of the site in terms of what it manufactures, emphasizing links with consumer products if these are not obvious.

» Practicalities (health and safety, risk assessment and insurance), date and duration, transport, size and age of group, needs of any students with learning difficulties of physical disability, meeting venue, attire, refreshments, and, if appropriate, display materials.

In the words of some Salters' Advanced chemistry teachers, from the experience of visiting a chemical site, students gained the following:

✔   motivation

✔   more confidence

✔   improved problem-solving skills

✔   meeting with industrial chemists improves the relevance of school chemistry

✔   better understanding of large-scale production

✔   insight into career opportunities

✔   an opportunity to do "real" investigations.

The teachers cited that the new knowledge the pupils acquired about the chemical industry ranged from providing a totally new image of industry to specific pieces of information about industrial jobs or processes. The outcomes that were most significant for teachers were those that related to their teaching. Sixty-four per cent of the teachers felt they had learned

how to teach about industry, 40 per cent had learned about how to teach science more effectively, and 31 per cent had learned about using industrial contexts to teach science.

All of the teachers felt the pupils had responded positively to the classroom activities. Seventy per cent of the teachers described the motivation and enthusiasm with which the pupils responded. They could see that the real industrial context and contact with industry provided pupils with a reason for doing science.

2.6.1 Field Trips

Outdoor activities (field trips) have the potential to enhance constructive social relationship among students as well as many of the variables that characterize learning environment measures. To create a healthy environment, there is a need for more research that will assess how time spent on field trips affects student's perceptions of the learning environment. It is desirable to further study the effect of different modes of field trips in the context of different science subjects on the learning environment.

A field trip is a process-oriented approach which focuses on an active interaction process between the students and the environment. In this process, students actively construct information from teachers. The advantage of active learning over passive learning is based on constructivist theory as well as outcomes of studies conducted in this domain. A field trip conducted as an integral part of particular curricular unit should be placed as early as possible in the learning sequence to provide a more concrete

basis for understanding the abstract concepts. Students should be properly prepared for the field trip. The preparation should employ concrete activities to reduce the effect of the 'novelty space' of the outdoor event.

School-based field trip takes place in a more open, flexible and democratic environment and has a potential for providing for instructional techniques that are more 'student centred'. It can provide students with concrete experiences, allowing them to interact physically and to manipulate objects which are usually unavailable in the formal science classroom. The field trip needs to be recorded if it is to be of maximum utility in teaching.

Casual visit to museums and zoos, botanical gardens, outdoor parks etc., can be called as 'free-choice learning environments'. Exhibits seen there can be designed as teaching or learning devices at four distinguishable levels:

(i)   <u>Experiencing</u>: the exhibits presenting phenomena occurring in nature.

(ii)   <u>Exploring</u> : interacting with and manipulating the objects discovering new features.

(iii)   <u>Explaining</u> : conceptual levels involving cognitive issues or mental models.

(iv)   <u>Expanding</u> : leading to generalizations comparing with other related exhibits.

These levels can be used as taxonomy for the preparation of paper and pencil as well as observational measures aimed at assessing the

educational effectiveness of certain exhibits in museums or informal settings.

Kuteinen et al (1988) report about the industrial visit model of learning. The factors essential are

(1) Providing young people opportunities for actual interaction with industry and

(2) Demonstrating the relationship between school physics and chemistry and industrial processes.

During the arrangement of the programme, interesting practical questions may arise in connection with the teacher-school and teacher-society relationships. The model of an activity-based industrial visit is not rigid and allows variation within wide limits. The most important contribution of the model is that the relevance of what is learned at schools has become obvious.

A field trip is a process-oriented approach which focuses on an active interaction process between the students and the environment . In this process, students actively construct information from teachers. The advantage of active learning over passive learning is based on constructivist theory as well as outcomes of studies conducted in this domain. A field trip conducted as an integral part of particular curricular unit should be placed as early as possible in the learning sequence to provide a more concrete basis for understanding the abstract concepts. Students should be properly prepared for the field trip. The preparation should employ concrete activities to reduce the effect of the 'novelty space' of the outdoor event.

Studies conducted in foreign countries clearly show that learning outdoors is very effective in imparting multilevel learning. In China, many secondary schools organize out of school activities to meet local needs. Some urban schools are actually producing chemicals and some rural schools organize practical advice on the use of pesticides and fertilizers. The teachers direct students to relevant documents according to the local needs, instructing them to search for information and carryout experiments. In addition to these activities the schools often took students to visit chemical plants, encouraged investigations, writing of reports and giving lectures. These out-of class activities have greatly increased the students' interest in chemistry, improved their operational skills and reinforced their theoretical knowledge.

The instruments for data collection according to Feasey (1998) include:

(i)   Field notes (the researcher's written account of what they hear, see, experience, and think in the course of collecting and reflecting on the data);

(ii)   Field jottings (quick notes about something the researcher wants to write more about later);

(iii)   Field diary (a personal statement of the researcher's feelings, opinions and perceptions about others who are the subjects of the study);

(iv)   Field log (a sort of running account of the researcher's plan for collecting his/her data systematically).

Interview methodology has been developed very intricately in qualitative research. In depth interview is a favoured strategy for data collection. It includes 'rich' data. Informal interviews are conversations where an observer might ask about the observed activities. The unstructured interview begins with a broad, open-ended question within the topic area. Prompts or short questions can be used to elicit ideas. The semi-structured interview has a more specific research agenda and is more focused. Researchers have to be aware of interview bias and guard against it.

2.7. Inter-relatedness of chemistry and industry

A thorough grasp of chemistry is a great asset to many jobs. Thus we can say that an individual's every moment is directly influenced by the understanding and therefore the utilization he or she can make of chemistry. Scientific discoveries, technological advances, the efficiency of work force, the exercising of citizen's rights and quality of life etc. are directly tied to the teaching of chemistry. Due to wide spread application, chemistry has become an indispensable subject for most of the optional combinations in science faculty. Appreciating the importance of chemistry, Saxena (1977) pointed out the functions of chemistry in our daily life. He opined that chemistry creates things for better living and makes it possible to utilize the waste material.

The real challenge for the teacher is to communicate the essence of chemistry and show how chemistry works by discussing a large variety of case studies and good examples from real chemistry. There have been many innovative undergraduate programmes in several universities directed towards this end, but greater efforts are needed. This challenge has

to be answered by the entire chemical education community world-wide (UNESCO, 1992).

Joy (1998) conducted a study on the extent of high school pupils' awareness of environmental chemistry and its effect on their achievement. The main findings of the study are.

1. There are a number of concepts in Chemistry, which has association with the environment and daily life situations.
2. There are a number of environmental situations where Chemistry is applied.
3. Our high school students have very poor awareness of environmental chemistry.

Oki (1990) while analyzing the problems of today's chemical education comments on the relation to chemical industry. He says that industry poses a serious problem for science education owing to the speed of innovation. The best way to handle industrial chemistry, according to him is to deal with industrial production or the production of industrial products as an application of extension of classroom study.

For chemistry teaching in the future, the goals have to be set in a different light than in the past. Everybody needs sufficient knowledge of chemistry to function effectively in the present day society. Students should be encouraged to investigate, to explore, to use the library, to use the natural environment and to discuss chemical concepts and issues in order to provide them sufficient opportunity and experience to cope with benefits from the products and processes of chemistry throughout their lives (Yadav,

2001). If we accept the need for active learning and the fact that young people taking part in active learning experiences will use skills and processes, then any curriculum development model for chemistry education ought to bear this in mind.

Pure chemistry is very closely related to industry. Many of the industries in Kerala are either chemistry based or lean heavily on specialization in the subject. The important industries in the state manufacture fertilizers, ceramic goods, cement, paper, synthetic fibres, distilleries etc. The groups of industries also include metal industries, isolation of radioactive minerals, coir industries, fish and food processing and the like and these require specialists who have adequate knowledge of chemistry. It is assumed that identification of the education potential of industries will help in preparing and improving the much needed manpower in these vital industry sectors.

The best way to handle industrial chemistry is to deal with industrial production or the properties of industrial products as an application or extension of classroom study. Students may become acquainted with the technological applications of substances and reactions. In learning about the production of Pig Iron, Copper, Aluminium, caustic lime, methanol, ammonia, sulphuric acid, the processing of coal and mineral oil etc. they see how technology and industrial production make use of what is known about substances and chemical reactions and how industries produce useful products from available materials. Further more a thorough grasp to chemistry is a great asset in many jobs.

It is important to orient the interest of learners towards the areas where chemistry will serve society and its development. For this,

students should become acquainted with local chemical plants. They get opportunity to assist the factory and the staff members. Good relationships are thus established between students and the staff of the factory. The students get acquainted with the working conditions, safety precautions, methods of production etc., which they can relate to their theoretical studies and the knowledge they have obtained from the course of analysis.

Pupils can extend the techniques of analysis that they learn in the school laboratory, by making use of a variety of instruments too expensive for a school laboratory but readily available in industry. This kind of education needs to be seen essential for job entry where training becomes unavoidable for improved job performance. Students themselves will be able to evaluate their own abilities and potentialities needed to enter and progress in a particular vocation or trade.

Teaching and learning in an industrial environment should focus on observation and description of common chemical reactions and processes and the subsequent rationalization of what have been observed. This may enhance students' enjoyment of experimental work and improve their attitude towards laboratory experiences. Hence chemistry teaching should emphasize the experimental nature of the subject in order to ensure the acquisition of know-how, to give a practical sense and to develop the capacity for observation.

Contextual/experiential learning shall enhance the young person's appreciation of how chemistry

a)   contributes to their lives and the lives of others around the world,

b)   helps them to acquire a better understanding of the natural environment,

c)   develop skills in techniques and procedures such as operating an instrument, devising conducting experiments etc.

2.8. Models of teaching and learning

The first model of school learning proposed by Carroll (1963) suggested that the learner will succeed in a learning task if s/he is given opportunity and allowed sufficient time to engage actively with the task until mastery is achieved. Carroll's (1963) model has had a considerable influence on research relating to school learning (e.g. Cooley and Leinhardt, 1975; Bloom, 1976; Harnischfeger and Wiley, 1976; Bennett, 1978; Haertel et al., 1983; Carroll, 1989) and has highlighted the importance of time, effort and motivation in determining achievement.

Most current models of school achievement have their basis in Carroll's ideas (Biggs and Moore, 1993; Creemers, 1994) and take account of the characteristics of the learner; the learning environment; the process of learning itself; learning outcomes and how the feed-back into the next learning situation (Biggs and Moore, 1993). Studies testing these models tend to confirm the multidimensional influences of a wide range of variables on learning (e.g. Fraser, 1989).

The models are fundamental to learning - in organizing ideas in such a way as to be able to predict effectively from experience. To predict the future on the basis of experience, the individual must store information in some structural way that corresponds to his environment. Bruner (1966) considers this to be the essential process of learning and

suggests that one way in which the individual can translate his experience is manipulation and action (enactive). The most important aim of any model of teaching is to improve the instructional effectiveness through an interactive atmosphere.

Silverman (2000) sees model as an overall framework to visualize reality. He gives a hierarchy of theoretical framework of model.

Table.2.2.

The theoretical framework of model by Silverman (2000)

Model	An overall framework for looking at reality (e.g: Feminism)
Concept	An idea deriving from a given model (e.g: Oppression)
Hypothesis	A testable proposition
Methodology	A general approach to studying research topics
Method	A specific research technique
Findings	

Gagne's model for the design of instruction includes a sequence of external, instructional events that guide the design of instruction. Instructional events, according to Gagne's framework, must first gain the student's attention and then provide a means to share the goals of instruction. Next, instructional events must be designed that stimulate recall, provide presentations in all modalities, and create linkages to meaningful frameworks. The final three instructional events

must monitor and adjust student learning, require application, and bring closure to learning. For each of these phases, Gagne has aligned internal learning events with each of the external instructional event

Table 2.3. summarizes Gagne's original conditions of learning model and adds Wiburg's affective/cognitive conditions.

Table 2.3

Relationship of instructional events to learning events

Instructional events	Affective/ Cognitive Conditions	Internal Learning Events
Gain attention	Ability to attend	Attend
Share goals of instruction	Emotional desire for learning	Expectancy
Stimulate recall	Ability to retrieve	Recall of related info
Present in all modalities	Auditory and visual processing ability	Perception
Provide meaningful frameworks	Learner schema relevant to new concept	Encoding in long-term memory in meaningful ways
Monitor and adjust	Feeling of getting it	Oh, I see. I get it.
Require application	Intellectual confidence	Secure schema
Closure	Satisfaction	Retention

Reflective level teaching model, developed by Hunt (1974), aims at equipping students with the power of acquiring, analyzing and discovering the knowledge. Reflective level learning enhances a better learning atmosphere for the students. The learner examines facts and generalization and seeks out new one. The teaching-learning at the reflective level involves careful and critical examination of an idea or problem in the light of the empirical or testable evidence that supports it and the further conclusions towards which it points.

In Pollard's (1990) social-constructivists model of the teaching/ learning process, he stresses the importance of the teacher as a 'reflective agent' with a role which is dependent on the sensitive and accurate assessment of a child's needs. This places a premium on formative teacher assessment of pupil understanding.

The learner has to be seen as active – by this, we do not mean using discovery learning, but that the learner is encouraged to think about what he/she is learning, to make sense of it and to link it with other concepts, constructs or pieces of information. It helps for the learner to be aware of his/her own learning strategies – again an active process. Finally the setting of learning and, crucially, the interactions between teacher and pupil, and between pupil and pupil, have important roles to play in the learning process.

The use of model requires an ability to specify precise learner outcomes so that a specific model can be selected to match a particular goal. Learning takes place when it is the result of the sensing of a problem which is of deep concern to the individual, rather than when he is confronted with a body of subject matter to be mastered. Many studies have been conducted on the effective use of models in the teaching learning process.

Jaimeni (1991) indicated that although both Advance Organizer Model (AOM) and Concept Attainment Model (CAM) were equally effective in fostering concept learning, the AOM was

comparatively more beneficial in concept learning to pupils with high divergent thinking while CAM was more beneficial to pupils with low divergent thinking. The AOM was found to be more effective than the CAM in retention of concept irrespective of the levels of divergent thinking of pupils.

Bhalwankar (1985) conducted a study of expository and guided discovery methods of teaching Mathematics on the achievement of students of different levels of intelligence. The study revealed that guided discovery and expository method were equally effective on achievement of knowledge and comprehensive objectives to both immediate post test as well as retention test. The expository method was significantly more effective than guided discovery method on the criterion of scores in the case of high intelligence.

Senan (2003) conducted a study on cognitive growth model and found that cognitive growth model (CGM) is more effective than the textbook oriented method on achievement in physics of secondary school students.

Thomas and Raj (1995) conducted a study on the effect of Advance Organiser model (AOM) on mathematics achievement and AOM is found superior to conventional method of teaching.

Rubin (1989) conducted a study by utilizing systematic modeling teaching strategy to promote the development of integrated science

process skills and formal cognitive reasoning ability. The study revealed the following:

i).   Students who have received modeled instruction demonstrated a significant difference in their achievement of process skills when compared to either of the control strategy groups

ii).   Students at different cognitive reasoning levels demonstrated a significantly different process skill ability

iii). There was significant interaction between teaching strategy and cognitive reasoning level with respect to process skill ability and

iv).   Students who received process skill instruction through different strategies demonstrated a significant difference in cognitive reasoning ability.

The work by Suckling et al (1978) on Chemistry through Models treats the entire subject of chemistry in terms of modeling. Some pedagogical and educational research works treating their themes predominantly as modeling were also highly influential in this study.

Thus teaching models provide the learning experiences by creating appropriate environment for real behavioural outcome. They follow scientific and systematic procedures to modify the behaviour of learners based on certain assumptions. All models of teaching specify the learning outcomes in detail on observable students' performance and mechanism that provide the students' reaction and interaction with the environment.

2.9. Conclusion

The review of related literature and studies in the fields of school learning, work-oriented learning and community-oriented learning shows that new and effective learning strategies are to be evolved. This must be done by integrating the features of learning in all these fields. The development and implementation of a model which combines both cognitive development as well as vocational training through first hand experiences (on-the-job education) will be a solution to this problem.

Higher Secondary Education is a crucial stage of education. It is at this level, that all the generalists, professionals and specialists required for the key positions for productivity in business enterprises, research, administration, planning, education and politics, can be trained through a variety of curricular programmes and offerings. Thousands of higher secondary students leave schools every year and then start the long and arduous process of looking for employment or further training. They must be educated and trained to suit the world of work that the modern Indian society demands.

References

Abraham, J. (1997). *Preparation and testing of a module on 'Aquaculture' for Degree students.* M.Phil. (Edu.) Thesis, University of Kerala, Trivandrum

Adamson, S. (1992). *New Perspectives in Chemical Education.* Chemistry Education, Vol. 8, p. 44-45.

Aldrich, H. E. (1999). *Organizations evolving*. London: Sage Publications.

American Psychological Association (1997). *Publication Manual* (4th edn.), Washington DC: Author.

Ames, C. & Ames, A. (1992) Classrooms : goals, structures and student motivation. *Journal of Educational Psychology,* 84(3): 261-271

Anderson, O.H. (1969). *Towards more science instruction in Secondary Education*. New York: McMillan.

Arends, R.I. (1997). *Learning to teach*. New York: McGraw-Hill, Inc.

Arsenson, L. J. (1996). An assessment of zoo reach program as a model for the development of informal education programs. (Ph.D thesis, University of Southern California). *Dissertation Abstracts International, 57* (2), 1996, p. 627A

Baez, A. V. (1976). *Innovation in science education-worldwide*. Paris: The UNESCO Press.

Bayliss, V. (1998). *Redefining School,* London: Royal Society for the Encouragement of Arts Manufactures and Commerce (RSA).

Bey, T.M. (1996). *Making school a place of peace*. California: Corwin Press Inc.

Bhalwankar, A.G (1985). *A study of effects of exploratory and guided discovery methods of teaching mathematics on the achievement of students of different levels of intelligence.* Unpublished doctoral Dissertation, Poona University.

Biggs, J.B & Moore, P.J. (1993) *The Process of Learning.* New York: Prentice Hall

Biggs, J.B. (1996) Enhancing teaching through constructive alignment. *Higher Education,* 32(3): 347-64

Bindu, S (1995). *Preparation of guided study module in Zoology at degree level for learning about domestic fowls and certain aspects of poultry farming*. M.Ed. Thesis, University of Kerala, Trivandrum

Binu, T. (1997). *An investigation into the curricular potentials of select plants bearing commercially important flowers for the study of certain major concepts in Botany at B.Sc. level.* M.Ed thesis, University of Kerala, Trivandrum.

Binumon, T (2000). *Effectiveness of three approaches of instruction-Modular Lecture-cum-modular and Conventional Lecture- in learning the topic 'fishery' at plus two level'* M.Ed. Thesis, University of Kerala, Trivandrum.

Bode, B.H. (1922). *Fundamentals of Education.* New York: the Macmillan Company.

Brown, J. S., Collins, A. & Dugid, P. (1989). Situated Cognition and the culture of learning. *Educational Researcher*, 18(1), 32-41.

Bruner, J.S (1966). *Towards a theory of instruction.* Cambridge, Mass: Harvard University Press

Bruner, J.S (1996). *Towards a theory of instruction.* Cambridge, Mass: Harvard University Press.

Bury, N.F.N. (1953). *The Teaching of Chemistry in Tropical Secondary Schools.* London: Oxford University Press. p. 112

Campaign for Learning (2003). *http://www.campaign-for-learning.org.uk*

Carroll, J.B. (1963). A model of school learning. *Teacher College Record,* 64: 723-33

Conrad, W.H. (1995). A constructivist-based instructional approach to help fifth-grade students improve selected elements of scientific literacy. *Dissertation Abstracts International, 57* (1), 158-A

Creemers, B. (1994). *The Effective Classroom,* London: Cassell.

Crompton, J.L & Sellar, C. (1981). Do outdoor education experiences contribute to positive development in the positive domain? *Journal of Environmental Education, 12*(4), 21-29.

Devadas, R.P. (1999). Universities and productivity. *Research Highlights- Journal of Avinashalingam Deemed University (JADU), 9* , p. 96

Doyle, W. (1984). How order is achieved in classrooms: An interim report, *Journal of Curriculum Studies,* 16(3) : 259-77

Driver, R (1989). The construction of scientific knowledge in school classrooms. In Millar R. (Ed). Doing Science: Images of Science. *Science Education*. London : Jalmer Press,pp. 61-81

Ebel, R.L. (Ed.) (1969). Outdoor education. *Encyclopaedia of educational research* (4th ed.). London : The Macmillan Company, pp. 921-924.

Eisner, E.W. (1996). *Cognitive and curriculum reconsidered.* London: Chapman.

Encyclopedia of Science and Technology (1982). New York: McGraw-Hills Book Co.

Evans, T and Nation D. (Eds). (2000) *Changing University Teaching-Reflections on Creative Educational Technologies*. London: Kogen Pages

ERIC (1982). (Educational Resource Information Centre). *Thesaurus of ERIC. Descriptions (9th edn.)*. Phoenix, Arizona: Oryx Press.

Falk, J.H. and Dierking, L. (2000). *Learning in Museums.* Washington, DC:Whalesback Books.

Feasey, R.. (1988). 'Science and industry links in initial teacher training', *Education in Science,* November, pp. 12-13

Fraser, B. (1989) Research syntheses on school and instructional effectiveness. *International Journal of Educational Research,* 13(7): 707-18.

Gaskell, P.J & Hepburn, G. (1997). Integration of academic and occupational curricula in Science and technology education. *Science Education, 81*(4), 470.

Geethalekshmi, K. (1994). *Identification of the curricular potentials of certain local edible fruit-yielding plants for the study of Botany at pre-degree level,* M.Ed. thesis, University of Kerala, Trivandrum.

George, Susan (1989). *Difficulties experienced by teachers of the vocational higher secondary education schools of Kerala.* M.Ed. thesis, University of Kerala, Trivandrum.

Government of Kerala (1987). *Vocational higher secondary education: A project report on proposed plant of action for 1987-1988.* Department of Vocational Higher Secondary Education, Kerala, Trivandrum

Grace, Neela, A.(1994). *Physics curricular potentials of small scale industries in Madurai district.* M.Phil (Edu) thesis, Madurai Kamaraj University, Madurai.

Grubb, Norton (Ed.) (1995b). *Education through occupations in American high schools Vol II: Approaches to integrating academic and vocational education.* New York: Teacher's College Press.

Han, Eun Sok (1991). A comparative analysis of teacher / school administrator attributes toward outdoor education/ school campaign. Doctoral dissertation, University of Massachusetts. *Dissertation Abstracts International,* 52(2).

Holman, J .(Ed). (1994). *Science World, Teachers' Resource Book*. London: Nelson Blackie.

Jaimeni. N (1991). *Effect of teaching strategies on conceptual learning efficiency and retention in relation to divergent thinking*. Unpublished Doctoral Dissertation, University of Delhi.

Jayaraj, W.D. (1997). ***Chemistry curricular potentials of chemical-based industries of Tamil Nadu,*** Ph.D (Edu.) thesis, Madurai Kamaraj University, Madurai.

John, R.(2000). ***Effectiveness of guided field study method for teaching Ecology at higher secondary level***. M.Ed thesis, University of Kerala, Trivandrum

Joliffe, A & Stevens, D. (2003). ***The outline learning handbook developing and using web-based learning.*** New Delhi : Crest Publishing House

Joseph, N.T (1976). ***A study of the potential and practices of using out-of-school resources in conducting science clubs.*** M.Ed. Thesis, University of Kerala, Trivandrum.

Joy, B.H. (1985). ***Extend of High school pupils' awareness of environmental chemistry and its effect on their achievement.*** Unpublished M.Ed. Thesis, University of Kerala.

Kasiviswanathan, T.S (1997). ***History curricular potentials of certain monuments in Tamil Nadu.*** Ph.D (Edu.) thesis, Manonmaniam Sundaranar University, Tirunelveli.

Kelly, A.V. (1999). ***The curriculum: Theory and practice*** (4th ed.). London: Paul Champan Publishing Ltd.

Key, M.B. (1998), ***Students Perceptions of the Chemical Industry: Influences of Course Syllabi, Teachers, Firsthand Experience.*** York: University of York

Krishnankutty, T (1997). *Development-oriented curriculum models relevant for coastal students,* Ph.D. (Edu.) thesis, University of Kerala, Trivandrum.

Lelitha, R. (1994). *An analysis of the curricular potentials of select medicinal plants leading to the study of Biology at secondary school level.* M.Ed. thesis, University of Kerala.

Mason, L.C. (1992). Concept mapping : A tool to develop reflective science instruction. *Science education*, 76 (1), 51-63

Meyer, G.R. & Rao, A.N (Eds.) (1984). *Teaching Science out-of- school with special refrence to Biology.* Sydney : International Union of Biological Sciences, pp. 133-150.

Miller, Richard H. (1988). Adding relevance to science teaching through outdoor education. *Dissertation Abstracts International, 48* (1), 2844 A

Myer, C.F. & Lee, E.W. (1980). The field trip as aesthetic experience. *Science Teacher, 47* (4), 116-119.

Novak, J & Godwin, D.B (1984). *Learning How to Learn*. UK: Cambridge University Press.

Oki, M. (1990), Problems in Chemical Education Today and their possible answers. *New Trends in Chemistry Teaching.* Vol. 6, Paris: UNESCO, p. 48-52.

Okon, K.J. (1993), Semantic Construction of Relationships in Curriculum of Algebra II and Chemistry. *Dissertation Abstract International,* Vol. 54 (12).

Oliver, R (2000). Using new Technologies to create learning partnerships. In Evans, T & Nation D. (Eds) (2000) *Changing University Teaching- Reflections on Creative Educational Technologies.* London: Kogen Page. P. 149.

Orion, N (1993). A practical model for the development and implementation of field trips as an integral part of the science curriculum. *School Science and Mathematics, 39,* 325-331.

Orion, N. & Hopstein, A. (1994). Factors that influence learning during a scientific field trip in a natural environment. *Journal of Research in Science Teaching, 31,* 1097-1119.

Orion, N. et al. (1996). Development and validation of an instrument for assessing the learning environment of outdoor science activities. *Science Education, 81* (2) 161-171.

Parvin, J., (1995). *Site-Seeing: Safety,* York: University of York.

Perin, D. (1998). *Curricular and pedagogy to integrate occupational and academic instruction in the community college : Implications for faculty development.* East Lansing, MI: National Centre for Research Service No. ED 4287937, p. 58.

Philip, V. A. (1992). *Potentiality of the livestock management curriculum of the vocational higher secondary education in Kerala for developing vocational skills in students.* M.Phil (Edu) thesis, University of Kerala, Trivandrum.

Pollard, A. (1990). Towards a sociology of learni9gn in primary school, *British Journal of Sociology of Education,* 11(3)

Pramling, I. (1990). *Learning to learn: A Study of Swedish preschool children.* New York: Springer-Verlag.

Raughton, J.L. (1997). Colorado community college and occupational education system: A culture structured for innovation. *Community College Journal of Research and Practice, 21* (21), 241-259.

Resnick, L. (1987). Learning in school and out. *Educational researcher*, 16(9): 13-40

Santos, G.J. (1988). Nature's classroom: Its short and long term impact on students, *Dissertation Abstracts International, 48* (1).

Santos, G. J. (1988). Nature's classroom. Its short and long term impact on students. *Dissertation Abstracts International, 48* (1).

Savadamuthu, M. (1989). *Chemistry curricular potentials of chemical-based small scale industries.* M.Phil (Edu.) thesis, Madurai Kamaraj University, Madurai.

Scaria, M. (1984). *Identification of the curricular potentials of select local plants of food value for the study of Biology at secondary school level.* M.Ed. thesis, University of Kerala, Trivandrum

Senan C., D (2003). *Effectiveness of cognitive development model on achievement in Physics of Secondary school students.* Unpublished M.Ed. Dissertation, MG. University, Kottayam.

Shepard, L. (1992) What policy makers who mandate tests should know about the new psychology of intellectual ability and learning. In B. Gifford and M. O'Connor (eds.) *Changing Assessments: Alternative Views of Aptitude, Achievement and Instruction,* London : Kluwer.

Silverman (2000). Theoretical Framework of Model. In In Evans, T & Nation D. (Eds). (2000), Changing University Teaching-Reflections on *Creative Educational Technologies*, London: Kogen Page .

Singh, U.K, & Sudarshan, K.N 1996). *Vocational Education*. New Delhi : Discovery Publishing House.

Sivadasan, K.R (1987). Effect of classroom learning situations on the attainment of objectives of science education in secondary schools. *Indian Dissertation Abstracts, 24* (2): 64

Smith, A. (1998) *Accelerated Learning in Practice,* Stafford : Network Educational Press

Sreekumar, V. (1992). *Biology curricular potentials of small scale industries in Kanyakumari district.* M.Phil (Edu.) thesis, Madurai Kamaraj University, Madurai.

Suckling et al (1978). Chemistry through models. U.K. Cambridge University press.

Sulochana, K. (1984). *Preparation of certain instructional models for learning science in high school classes based on farming.* M.Ed. thesis, University of Kerala, Trivandrum

Susan, T.A. (1990). The latent curriculum in agro-based occupations. *Paper presented at the "National seminar on Curriculum Development in Higher Education".* July 23-26, 1990, organized by the Department of Education, University of Kerala.

Susan, T.A. (1983). *Preparation and testing of models for maximizing educational achievement through the medium of sports and games.* M.Ed. thesis, University of Kerala, Trivandrum.

Swafford, C. L. (1995). Developing a model for using the outdoor laboratory in elementary school science. (Ph.D thesis, the University of Tennessee) *Dissertation Abstracts International, 57* (2), 631-A

Thomas, B & Raj, M.(1995). *A study of the effect of advanced organizers in mathematic achievement in comparion with the conventional method of teaching at secondary school level.* Unpublished M.Ed. thesis, MG. University

UNESCO (1992). *Project 2000+: An International project on scientific and technological literacy for all: Preparing for the year 2000 and beyond,* June 1992, p. 21.

Valsala, G. (2002). Environmental education potential of Botanic Gardens. Ph. D (Edu) thesis, MG. University, Kottayam.

Waddington, J.D. (Ed). (1984). *Teaching school chemistry*. New Delhi: Sterling Publishers Pvt. Ltd.

Watkins et al. (1996). *Effective Learning,* London: Institute of Education School Improvement Network (Research Matters series) http:www.ioe.ac.uk/iseic/research.pdf)

Wellington, J.J (1981). What is supported to happen …..? Some problems with discovering learning. *School Science Review* 63 (222) pp. 167-173.