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CHAPTER - I

INTRODUCTION

1.0. Chapter preview

This chapter is intended to identify the importance of technology-based learning in different walks of human life. It discusses the relevance of industry-institute interactions and relevance of using industrial environments for better learning of chemistry at school level. It also deals with the significance of chemistry education in an on-the-job setting. This chapter also explains in detail the objectives, methodology and data base of the study, with its scope and limitations showing the direction and pathway of this research work.

1.1. Introduction

The Prime Minister's Economic Advisory Council (EAC) recently projected the net inflow of Foreign Direct Investment (FDI) at $9 billion for 2006-07 as compared to 4.7 billion in the pervious fiscal. This path-breaking FDI in the context of globalization and the development of industrial sector, especially IT industry, free marketing and outsourcing demands the need for education-industry interaction for the development of the skills appropriate for the job the students select later.

The universities in India did try to establish a tie-up with industries. But their efforts became futile. They never realized the inevitable role of school for the development of professional skills. Had the authorities introduced in schools a scheme for the development of professional skills, the universities would have succeeded in achieving their dream of a tie-up with industries. It is high time that researchers in India attempted to prepare a roadmap for the schools to develop the primary skills.

Educators have long realized that active participation of the learner in the learning process enhances learning. In the early 1900s John Dewey urged reorganization of the curriculum and instruction to make student participation a central part of the process. In the late 1970s and 1980s, educators felt that education should go beyond programmes to learn isolated skills and memorize facts that were characteristic of much school curriculum. They called for more emphasis on the abilities of students to solve problems, find information, and think critically about information; in other words, they called for more emphasis on learning how to learn instead of learning the specific content. The emphasis on individual learning also drew criticism because students do not develop the ability to work together in groups, which is an important workplace competency for the 1990s and beyond.

Educators are expected to design opportunities for students to engage in the kinds of activities that support and shape the ability to think and solve problems. These activities should help students become competent with at least four categories of cognition: memory, information extending processes, information rearranging processes and metacognition (Patel & Greon, 1986). Moving from knowledge to understanding involves performances of understanding. Constructing activities is performance activities that asks students to expand reform, apply or extend their knowledge by making something, producing something, building something or creating something. The outcomes of constructing activities serve as observable performances of understanding.

1.1.1 Designing opportunities for learning

Learning takes place in a context. In designing the context, learning environment is as important as the designs teachers create for knowledge, problem solving and information use. Cognitive and constructive psychology suggests that learning is a process of knowledge construction (Glaser, 1984; Driver et al., 1985). It is a process which brings about changes in the individual's way of responding as a result of contact with aspects of environment. Teachers who view learning from this perspective emphasize different elements for assessment than those used in standardized tests. They notice the knowledge and skills their students bring to the class, observe how students interact and solve problems and then provide multiple ways for students to learn and demonstrate their learning.

The design of learning opportunities permits teachers to construct opportunities for their students that are responsive to the unique learning contextual and personal characteristics of a learning environment.

Hence new ways of designing learning are needed. The design of opportunities to learn must include careful consideration and selection of tools which are consistent with and supportive of the intellectual challenges presented to the learners (Meier, 2000).

Student learning is not accidental; it is the direct result of student's experiences of the learning opportunities teachers design. The purpose of designed instruction is to activate and support the learning of the individual student. This aim is characteristic of instruction wherever it occurs, whether between a tutor and a single student, in a school classroom, in adult interest group, or in an on-the-job setting (Gagne & Briggs, 1974). The way in which students are able to involve, co-ordinate and apply their basic knowledge, is central to the success of making application contexts work. To Gandhiji, school itself is the workshop where work is an essential instrument of learning.

Today learners seek a shift away from teaching to learning and they want to learn by doing, experiencing, inventing and creating rather than consuming pre-packaged instruction. (Norton & Wiburg, 2003). The learning environment should extend beyond the classroom. Students know a great deal about the world and learn best when they connect what they learn with the world they know. Thus the redesigned learning environment must include links to the community and the workplace to develop students' abilities to solve problems and communicate effectively the kinds of skills they will need when they enter the workforce. Learning occurs in an ecosystem (Doyle, 1977) in which there is a series of inputs, a series of teaching learning processes and a series of outputs.

Experience is the acquired product of a learning process. Experience of a real and objective nature forms concrete ideas and concepts in a learning child. Providing such real and objective learning situations is of significant importance in educating a child, which sows the seeds of objective and scientific outlook in the children in understanding class subjects as well as surrounding environment. Thus teaching and learning will be excellent if teachers could arrange direct and first-hand experiences for each and every subject matter they teach.

It is necessary to imbibe in our pupil qualities such as divergent and convergent thinking, logical planning ability, social and communication skills and inquisitiveness and interest in the laws of nature besides imparting knowledge. Students need opportunities to engage in knowledge building activities that include, for example, reading and discussing ideas, watching demonstrations, viewing films, responding to questions and completing structured experiments. They should also be trained on the relationship between factors in relation to the development of technically or commercially successful products. This calls for a marked change in the content and methods of education.

Recent studies have shown that pupils can learn more complex skills and processes in a context with which they are familiar than when they are learning in a formal academic subject in the school curriculum. Pupils' learning is influenced by collaborating with other children, interacting with the teacher and with their environment. In order for successful learning to take place teachers must establish a safe environment and a purposeful working atmosphere.

There is also an ever-growing trend towards globalization of production, services and engineering. Industry is another setting where "private systems" of education operate (Travers, 1990). This calls for a marked change in the content and methods of education with increased emphasis on international standards, trade etc. Widespread influence of chemistry on general education is necessary if we want each individual to be self-conscious of an intelligible linkage between human life and human work. A well programmed interaction of industry and institution is what is needed to equip the students with the required degree of skill, i.e. combination of knowledge, practicality and experience.

The constructivist theories of learning (Driver and Oldham, 1986) emphasize learning as an active process which requires the individual to interact with the environment and to make sense of what he experiences in relation to his own previously held conceptions. Opportunities have to be provided for students to articulate their own prior understanding before being exposed to new experiences and then, through discussions with their fellow students, they should be encouraged to accommodate new ideas to their own. The role of student discussion is fundamental to bringing about the required conceptual changes (Needham and Hill, 1987).

In contrast to presentational teaching, facilitative teaching encourages students to take deep approach to learning and development of higher order abilities such as critical thinking and learning how to learn. Facilitation of deep learning uses reflective and collaborative teaching strategies to externalize meaning, provide alternative explanations, diagnose misconceptions and confirm meaning within a context that provide choice and respect (Garrison & Anderson, 2000).

The success of student learning accrued from constructivist principles and experiences largely depends on how they are capable of reflecting over their 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.

1.2. Need and significance of the study

In the light of the educational scenario of the nation presented elsewhere, the investigator tries to locate in this section the problem for the study and its significance.

Apprenticeship is an old concept. Up to the end of 19th century it had been the strategy for the learning of traditional trades from the elders of the family. This learning strategy gradually metamorphosed into post-professional practice of what the students have learned during the course. It is thus used today not for learning, but for prasticing what they already learned.

In the advent of globalization and free marketing, India needs highly skilled professionals to compete with the developed countries by enriching Intellectual Property rights (IPR). This can be achieved only by imbibing in students the intellectual skills like critical thinking, logical thinking and independent thinking and also by developing their ability to 'create' knowledge rather than acquiring the existing knowledge. In order to 'create' knowledge, students should practise constructing old knowledge. Can we achieve this by reversing the purpose of apprenticeship as a learning strategy? This is a problem that made the investigator assume that apprenticeship can be employed as an instructional strategy, if constructivist theory of learning and experiential learning are employed in the interface of reflective practice.

The major output of an institution is its outgoing students. Schools generally emphasize basic knowledge, especially fundamental concepts and principles. When the present education system stresses the importance of analysis, criticism and acquisition of knowledge, it neglects the information of solutions to problems, planning, organization and preparing in fact the constructive and creative roles. There is a tendency to neglect the practical needs of students. The conventional school work involves students in abstract symbol manipulations that are often divorced from connections between the symbols and the real world to which they refer. Outside the school, pupils either manipulate the stuff of the real world directly, or if that is not possible, they work with symbols closely connected to their activities.

Conventional school-based learning too often fails to mesh the knowledge in the curriculum with the contours of wider experiences. The capacity to make knowledge coherent and consistent across the range of our experience and actions is not sufficiently developed by mainstream education, as it is constrained by curriculum and time demand, limited resources and a reliance on text-based assessment. This fact offers a warning to educational reforms which focus too heavily on producing correct answers in narrow contexts. Majority of the methods now adopted in the classrooms neglect the mental abilities such as scientific observation, conceptualization, inquiry, hypotheses formation, logical reasoning, etc., which are important in reflective learning. But these traits can be developed by reflective practices which enhance critical thinking and arriving at conclusions in a meaningful way.

During the last four decades many new methods of teaching and training have been developed, tested, modified and adapted to different kinds of learning situations. In the words of Joyce & Weil (1990), “to provide an all round development, we need to design suitable instructional strategy (ies) which helps our students grow emotionally, socially and intellectually. There still exists a big gap between theoretical knowledge and actual teaching in the classroom or schools. Models of teaching as strategies need to be incorporated in our teaching practice”.

Many parents and educators feel that traditional methods focus too narrowly on breaking topics into discrete skills and teaching them systematically. They blame this limitation for poor national test scores on more global skills of problem solving and reasoning (Cognition and Technology Group at Vander bilt [CTGV], 1991). The CTGV report says that "the thinking activities that are of concern include the ability to write persuasive essays, engage in informal reasoning, explain how data relate to theory in scientific investigations and formulate and solve moderately complex problems that require mathematical reasoning". More recently cognitive theories of learning, which focus on internal mental processes, have supported the principle that effective learning demands active manipulation of information by learners. Brown et al. (1989) suggested that teachers could prevent the problem of inert knowledge by situating learning in the context of what they called authentic experiences and practical apprenticeships activities that learners considered important because they emulated the behaviour of experts (e.g., adults) in the area. In this way, students see the link between school learning and real-life-activities.

It is a known fact that the curricula have little relevance to our societal needs and no relation to local environment. Curricula are by and large theoretical and divorced from immediate environment. Learning by doing is the predominant way used to collect experience and to gain insight into scientific concepts. There are many opportunities for taking students outside of the classroom and carryout investigation to know better the content and ideas being discussed in class or to see science and technology in action. Provision of work experience in real working situations outside of the school is still a distant goal.

Several research studies were carried out, in this line, to study in detail the prospects and problems of higher secondary education in different states of India. These include those of Soundaravalli (1984), Pillai (1984), Sharma (1988), Pandit (1989), George (1989), Mahesan (1989), Bose (1990), Chaudhary, (1990), Joshi (1992), Nelliappan (1992), Rangaraj (1995), Pylant (1996), Kuriakose (1996), Mayor (1990). These studies indicate that the higher secondary curriculum does not, to the required extent, prepare students to enter the world of work. This necessitates the incorporation of job-oriented learning at school level to develop occupational and professional skills in children.

1.2.1. Apprenticeship system

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 itself is based upon book learning. Higher positions in any occupation or industry generally require a greater amount of book learning. Education is thus an important condition for occupational opportunity. Generally industrial societies are occupationally and socially more mobile than pre-industrial societies.

Vocational education in ancient and medieval times was provided through apprenticeship. In ancient India, vocation was on family basis, the son learned the vocation by working with his father. In carpentry, in the field of ayurvedic medicine, in farming etc. this was the practice prevalent in the society. Knowledge was transferred from one generation to the next 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 pupils 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.

In the past when the content in science was so limited that the practice of apprenticeship for learning was sufficient to acquire knowledge and practise it. Today when institutions are functioning for the students to learn, apprenticeship as a strategy for learning can hardly be used. Instead it has been used as a device to practise what they already learned in classrooms. The problem, in this context, is whether or not apprenticeship can still be used for learning in collaboration with industry and schools.

Instead of providing students with apprenticeship after completing study, if we provide them with an apprenticeship type of environment for learning during the academic course itself, we can expect simultaneous accommodation of knowledge and training. In professional courses, this apprenticeship based learning is incorporated somewhat effectively like bed-side teaching in the MBBS course, practice teaching in B.Ed course but practically no attempt was made to incorporate this type of learning at school level. Methods used for teaching/ learning in schools like field visit, project method provide some amount of direct experiences but this involves random collection of knowledge and demands little inductive or deductive thinking. The investigator herself experienced the same situation while she was teaching chemistry in the Vocational Higher Secondary (VHS) school.

Even though the vocational element is incorporated in the VHSE course, well planned activity-based or job-oriented education is not insisted on all stages. Vocational subjects includes limited number of project works and field study and general subjects like chemistry includes little or no activities of this kind. The students are taken for out-of school activities just like field visit and are directed to prepare study reports. Deep learning is not enhanced and the potential of outdoor learning environments is not fully utilized. As a chemistry teacher the investigator found it very difficult to arrange field studies, for providing students with direct and purposeful experiences and better learning. An industry-oriented learning, rather than training, will be a solution for this problem.

Experience has shown that courses on agricultural chemistry, biochemistry and pharmaceutical chemistry can be implemented quite successfully by the joint efforts of school and industry. The training at the secondary school should be conducted in such a way that it will provide pupils with some preliminary understanding of the work involved in the practical applications of chemistry.

In this context apprenticeship-based learning can be expected to be beneficial before the actual, formal, apprenticeship takes place. The on-the-job learning and training experience will be of great help in the students' future life and will provide concrete base to work in an industrial set-up. The placing of pupils in an industrial or commercial situation for a short time is a valuable method of gaining experience.

1.2.2 Education-Industry link

Today industrial environments are used as training centres by professional and technical students in the form of apprenticeship training after a formal course of study and also for a limited period of time. During this type of apprenticeship, the focus on training than learning and trainees practise knowledge they have already gained. They do not get any encouragement from the management to share the experience with the technical staff there. The management does not take the risk of handling the equipment by the trainee students. And since the students are not sure of their future employment, they do not take keen interest in the training.

Too often education and industry operate in isolation with the result that the products of our educational system have little or no appreciation of industry and are taken to be poorly prepared to perform the tasks that the modern industry expected of them. This isolation appears to be due to lack of proper appreciation of the fact that education-industry co-operation is a pre-requisite for sustained industrial development. Thus there is an urgent need to promote and strengthen proper linkages between educational institutions and the industry. This study is a beginning towards establishing school-industry relationships. It is expected that it will widen the scope of bringing together the school and industry for learning and practising simultaneously.

After thoroughly searching through all the literature related to apprenticeship learning and training, the investigator found that the studies conducted in India in this area were very limited. The investigator thus assumes that incorporating an Apprenticeship-Type Learning (ATL) in school education will be effective and meaningful, focusing more on systematic, experiential learning leading to constructing ideas and concepts in real life situations. Thus the investigator was motivated to take up this problem on the following grounds:-

1) The experience as a chemistry teacher at the VHSE level revealed the necessity for providing students with firsthand experiences in chemistry-related or chemistry-applied learning environments for meaningful and life-oriented chemistry learning at school level. Industrial environments are expected to be highly suitable for this kind of learning.
2) An industrial environment can provide students with varied kinds of knowledge and skills and teachers must seek better means for effective use of this environment for chemistry teaching.
3) It is not possible to teach students all about the technological developments at classroom itself. Providing students with firsthand experiences is all the more important.

4) Industries are actually considered unfathomable. Even the community has little chances to know about the industries. But educational institutions can do a lot for the sustainable development of industries. In turn, they can make use of the industrial environments for effective teaching and learning.

Hence considering the significance of school-industry linkages the investigator makes an attempt to identify the chemistry education potential of industries in Kerala with a view to developing better means for learning chemistry at school level, i.e., utilizing industrial environment as superb learning centre. The nature of learning that occurs at out-of-classroom contexts is considered in terms of its definition, its characteristics and a model that helps us understand how it is different from formal learning in classrooms. Thus an attempt is made to solve the following problem:-

1.3. Statement of the problem

This study is an attempt to develop a model for learning in an industrial environment. Usually industrial environments are used for training after completing a course, especially by students of technical courses. No attempt is made to incorporate this at school level, focusing more on learning rather than training. Assuming that apprenticeship-type learning in an industrial environment is an effective means for learning, the topic for research is presented below:-

"APPRENTICESHIP-TYPE LEARNING (ATL) MODEL – DEVELOPMENT AND ITS EFFECT ON HIGHER SECONDARY STUDENTS' ACHIEVEMENT IN CHEMISTRY".

1.4. Operational definitions of key terms

The key terms that need clarification are given below

Apprenticeship

Apprenticeship is the term applied to an on-the-job experience programme. It is part of a technical or professional education programme, intended for training after the formal course has been completed. In this context, the process of apprenticeship has a metamorphosis from practising after the course of study to learning the formal content during the course by working simultaneously as a student and an apprentice in the school-industry environment. In this study, the concept of apprenticeship has a different connotation as a learning strategy during the course rather than a device for practice after the course.

Learning

Learning is a process of active engagement with experience. It may involve the development or deepening of skills, knowledge, understanding, awareness, values, ideas and feelings or an increase in the capacity to reflect. Effective learning leads to change, development and the desire to learn more. (Based on the definition first used by The Campaign for Learning, 2003).

Apprenticeship-Type Learning

Experiential learning in an actual situation outside of the classroom, i.e. in an industrial environment, where learning takes place in the context of observing, doing and reflecting. Pupils are expected to behave like apprentices in technical courses, but concentrating more on learning rather than training. Here apprentice's role is primarily observational.

Model

A model of teaching is a description of a learning environment. The descriptions have many uses, ranging from planning curriculums, courses, units and lessons to designing instructional materials. All mature educational models emphasize how to help students learn to construct knowledge – learning how to learn (Joyce & Weil, 1996).

Achievement

It refers to the total score achieved by an individual as measured in the test constructed. It is the knowledge or skills developed by test scores or marks assigned by teacher or by both (Good, 1945)

Higher secondary level

Higher secondary level refers to any school recognized by the Government of Kerala imparting instruction to students at the XI and XII levels.

1.5. Hypotheses formulated

The Apprenticeship-Type Learning (ATL) model is to be developed, referring to the principles of constructivist learning etc. It is to be tested for its effectiveness as a new strategy for learning outdoors by formulating the following hypotheses:

Hypothesis I

Industrial environment has the potential for natural and meaningful learning of chemistry at school level.

Hypothesis II

A model for learning based on apprenticeship, by incorporating the principles of constructivist learning, experiential learning and reflective learning, is plausible.

Hypothesis III

Apprenticeship-Type Learning (ATL) Model is more effective than Direct Instruction (DI) on student achievement.

1.6. Objectives of the Study

The study has the following objectives in view:

1. To identify the structure and potential of some industries for chemistry education at school level
2. To develop the Apprenticeship-Type Learning (ATL) Model for the learning of Chemistry at school level
3. To find out the achievement of higher secondary students who learned Chemistry using ATL model.
4. To find out the achievement of higher secondary students, who learned Chemistry using Direct Instruction (DI)
5. To compare the effectiveness of ATL model and Direct Instruction (DI) on students' achievement in chemistry.

6. To assess ATL group of students' achievement of industrial concepts in Chemistry.
7. To identify the extent of interaction between school and industry when ATL model was used.

1.7. Methodology in brief

As the study focused on the various dimensions of school and industry as intellectual learning environments and the school-industry interaction, no single method or strategy was found to be sufficient for getting reliable data. The methods and techniques used for the study are given below:

i. To identify the chemistry education potential of industries – field visit, structure analysis and content/process analysis of industrial environments with respect to content analysis of the chemistry textbook at higher secondary level.
ii. To develop the Apprenticeship-Type Learning (ATL) model – A thorough analysis of
   a) the theories and principles of instruction, mainly based on constructivism, experience and reflection
   b) the models of teaching /learning used at various levels
iii. To study the effect of ATL model on higher-secondary students' achievement in chemistry – Experimental method
iv. To identify the modes of interaction between school and industry - Interviews with personnel in the fields of industry and education.

Any one method or a combination of methods was used, wherever necessary, to arrive at dependable generalizations.

1.8. Scope and limitations of the study

The potential of industrial environments for technical and professional education is well recognized. It is useful for learning at school level also, but empirical studies to establish this are very few. The study aims at identifying better means for interaction between school and industry for effective learning. It is hoped that the ATL Model and the Model Action Plan that are to be developed would be useful to students, teachers and curriculum planners. Thus the scope of the study envisages the following:

1. Pupils' initial views of factories and manufacturing sites are often stereotyped as dark and threatening places pouring out pollution. Teaching chemistry using industrial contexts and visits will be capable of changing these perceptions.
2. Revamping higher secondary school chemistry curriculum not only as a college preparation course for students but also as a preparation for entering into and progressing in the industrial sector.
3. Better chances of interaction between school and industry for learning.
4. The move towards the use of a variety of assessment techniques, especially those related to continuous assessment of psychomotor and affective skills.
5. The use of new technology to enrich existing curricula and improve the way in which they are taught.

The researcher has to point out that the present study being the first of this kind in India, there are limitations. They are:

1. The investigator confined the field study to some selected industries as it was a tedious task to study more industries. The study is confined to representative sample of students of standard XI from two districts. The sample is small for the results of the study to be generalized but availability of a large sample and feasibility of carrying out such an experimental study with large samples is beyond the control of the investigator.

2. As this kind of study is not being attempted earlier, there are limitations in arriving at a suitable design for the study and thinking of a better way of carrying out the study.

3. Time was a limiting factor as it was not possible to take students outside the school for a long period. Within the constraints of the industrial environments and the time schedule of the school, the data collection had to be limited.

4. The students' lack of experience in the industrial environments might have affected the outcomes of the study to some extent. But the school situation does not permit such an attempt.

5. A comprehensive evaluation at the industrial site was not so easy and this might have affected the generalizability of the results.

1.9. Format of the report

The report is presented in six chapters. Each chapter deals with the following:-

Chapter I Contains a general introduction with relevant sections of an introductory chapter, .

Chapter II Presents the review of related literature and studies pertaining to the area under investigation.

Chapter III Deals with the methodology of the study. It presents the design of the study, the methods and sample selected, the tools and techniques with which the data were collected, the procedure employed for collecting data and the statistical techniques applied for the analysis of the data.

Chapter IV Discusses the theoretical concepts and the steps involved in the preparation of Apprenticeship-Type Learning (ATL) Model. It also presents the model lessons for learning a particular topic, based on the model developed.

Chapter V Presents the details of evaluation of the ATL Model developed. It includes the data analysis of the experimental study, the discussion of the results and the outcomes of the study. It also presents a generalized form of ATL model and a model action plan for enhancing education-industry links.

Chapter VI Summarizes the study in retrospect. It presents the summary of the procedure, major findings, conclusions, implications of the study and suggestions for further research in this area. The report is supported with lists of Tables and Figures and Appendixes pertaining to the study.

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