CHAPTER VI

SUMMARY AND CONCLUSIONS

- ❖ **Chapter Preview**
- ❖ **Study in Retrospect.**
- ❖ **Outcomes of the study**
- ❖ **Conclusions of the study**
- ❖ **Implications of the study**
- ❖ **Suggestions for Further Research**

Chapter VI

SUMMARY AND CONCLUSIONS

6.0 Chapter Preview

The concluding chapter contains the summary of the study conducted. It presents the study in retrospect and the major findings. The concluding part of the chapter includes a discussion of the implications of the present study and suggestions for further research in the area of teaching strategies. There are five parts in this Chapter

6.1 Study in Retrospect.

6.2 Outcomes of the study

6.3 Conclusions of the study

6.4 Implications of the study

6.5 Suggestions for Further Research

6.1 Study in Retrospect

6.1.1 Significance of the problem

The question of relevance in science and technical education has received considerable attention in recent years. Some of the new teaching and learning materials developed with relevance in mind have been designed in such a way as to link them to the students' experience and make them fit in with the immediate and / or long-term needs and aspirations of society. Others emphasize the social implications of science and technology.

Children have their own ideas about physical phenomena that occur in their environment, long before they take a formal course. They develop these ideas in an attempt to make sense of what happens around them, and these internal representations are therefore very personal. They are also fairly stable and very persistent. Scientific thinking aims at generality and coherence and at understanding the relations between theory and practice.

Teachers who wish to encourage a 'doing' approach to understanding need to have a mind for the various forms of doing that help children assimilate the characteristics of something which is new to them. Central to any doing is 'investigation' and this usually immediately calls in to play the actions associated with 'observation'. Then investigations have to be designed and planned. Schools which favour an active approach to the learning of science will devote a great deal of thought to the many investigations the children might appropriately be asked to make, according to their age and maturity.

All round education is linked with readiness to participate in work. In productive labour students are gradually brought to touch with working people and are introduced to the realities of life and working conditions. The work done by students in the factory becomes the application of previously acquired know-how and skills. Production labour is a way of combining theory and practice in school. Under the guidance of skilled workers, students learn about work, they acquire the work skills, working habits and work experience.

In India, the job scenario is changing and the service sector is also on the rise. This would call for trained human power at various levels to fulfil our own demand and it demands for quality in higher education. This quality can effectively be brought about the closer links between school and industry. Students must be given opportunities to learn, to organize and co-ordinate field activities. For this they must be taken outside the classroom and allowed to acquire and construct knowledge out of their experiences.

Thus in this study it was proposed to develop a model for learning chemistry in an industrial environment. Apprenticeship had been once used for learning a trade. Today it is mainly meant for practice after a formal course of study rather than learning. The study aims at using the potential of an industrial environment for learning chemistry at school level. Apprenticeship as a mode of learning cannot be incorporated as such and hence it was thought of preparing an apprenticeship-type learning model, focusing more on learning than on practicing what the students have already learned..

The use of the model for learning will be termed successful when it can provide opportunities to the learner to develop skills and abilities to organize and co-ordinate field activities systematically according to pre-planning. Later students will be able to plan organize and execute the field-related activities on their own in co-ordination, with other environments. It may enable them to learn and acquire new knowledge by making efficient utilization of their theoretical knowledge and laboratory experiences in the field of practice at different stages and make substantial original contribution.

6.1.2 Statement of the problem

The problem for the study is stated as: **"APPRENTICESHIP-TYPE LEARNING (ATL) MODEL - DEVELOPMENT AND ITS EFFECT ON HIGHER SECONDARY STUDENTS' ACHIEVEMENT IN CHEMISTRY".**

6.1.3 Hypotheses formulated

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

Hypotheses I

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

Hypotheses II

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

Hypotheses III

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

6.1.4 Objectives of the study.

The study has the following objectives in view:

1. **To identify the structure and potential of certain 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.**

6.1.5 Research design

The design for the present study included the purpose of the investigation, the nature of the learning environment, possible means of making use of the maximum potential of the learning environment, the types of variables and the conditions in which the research was to be carried out. As the study focused on introducing Apprenticeship-Type Learning (ATL) model as a new learning strategy and in studying its effect on students' achievement, content /process analysis of the learning environments as well as the prescribed textbooks and experimental study were the major techniques used.

6.15.1 Tools and techniques used in the study

The tools and techniques used in the present study were:

1. Data Analysis Sheet for factories
2. ATL Model lesson transcripts
3. Observation Schedule for assessing the performance of the students.
4. Lessons for Direct Instruction.
5. Achievement Tests (I &II) in Chemistry.
    - I. Content Achievement Test (Pretest & Posttest) for both experimental and control groups
    - II. Industry Based Learning Test (Pretest & Posttest) for experimental group only.
6. Informal Interviews with people in the field of industry and education.

6.1.5.2 The sample for the study

The sample consisted of 170 higher secondary students (Std. XI), randomly selected, from two schools in two districts. Three groups of students were formed for collection of information. Group I (N=50) was earmarked for field study in the Kerala State Salicylates and Chemicals (KSSC) Limited. This field study was found as a pre-requisite to develop the Apprenticeship-Type Learning (ATL) Model.

After developing the model, to test its effectiveness students in Group II (N=60) of the same standard were allocated to another industry, viz. Travancore Cements Limited, where they would learn through the ATL Model developed. The students in Group III (N=60), being the control group, were assigned to learn in the conventional method of Direct Instruction. Both Group I and Group II belonged to non-equivalent intact classroom groups. Subsamples were grouped based on sex only.

6.1.5.3 Pre-preparation of the ATL Model

The pre-preparation stage of the ATL Model involved consultations with experts in the field of school education, higher education, technical education and field of industry for framing the sequence of learning events. Thus the stage consisted mainly of the following three steps.

(i) Analysis of the existing theories and models of teaching and learning.

At first the investigator made a thorough analysis of the existing theories and models of teaching and learning, to prepare the ATL model. This helped her a lot in framing the learning sequences/events of ATL model.

(ii) Identification of Chemistry Education Potential of some selected Industries.

In order to identify the chemistry education potential of chemical industries in Kerala, it was highly necessary to study the structure and functioning of industries. For this, field studies of selected industries were conducted by the investigator. Then the Chemistry syllabus at higher secondary level was analyzed. Textbooks, handbooks, resource books, supplementary reading materials, reference books related to the content and methods of teaching, pedagogical principles, etc., also were analyzed during content analysis. The data obtained from the field studies and content analyses were correlated and consolidated to identify the education potential of industries.

(iii) Empirical verification of the chemistry education potential identified.

In order to identify the chemistry education potential of chemical industries in Kerala, it was highly necessary to study the structure and functioning of industries. For this, field studies of selected industries were conducted by the investigator. Then the Chemistry syllabus at higher secondary level was analyzed. Textbooks, handbooks, resource books, supplementary reading materials, reference books related to the content and methods of teaching, pedagogical principles, etc., also

were analyzed during content analysis. The data obtained from the field studies and content analyses were correlated and consolidated to identify the education potential of industries.

6.1.5.4 The Preparation the ATL Model

The investigator studied the different aspects of industries in general and grouped them under different sectors keeping in view of the major products manufactured. To identify the chemistry education potential of some chemical industries in Kerala, at higher secondary level, the industry-related topics in the curriculum were located. It was conceived as a preliminary step for developing the Apprenticeship-Type Learning (ATL) model for learning chemistry in an industrial environment. A thorough analysis of the existing models of teaching/learning was made to prepare the ATL model. Consultations with experts in school education, higher education and technical education and in the field of industry were made for framing the sequence of learning events.

6.1.5.5 Evaluation of the ATL Model developed

Evaluation of the ATL Model developed was done on two mutually related aspects: effectiveness and usefulness. The effectiveness of the ATL Model developed was determined in the following way

i. A suitable site or chemical industrial environment was located in order to learn higher secondary chemistry.

ii. The topics in the HSS chemistry curriculum that can be learned within the industrial environment were identified

iii. Study materials for learning the topics identified at the selected site were prepared based on the ATL Model developed.

iv. Students were taken to the industrial environment and allowed to learn through materials and activities based on the ATL Model.

v. The students' achievement in chemistry and the extent/nature of their skills developed were assessed using appropriate techniques.

vi. The same topic was taught to students using Direct Instruction, and their achievement in chemistry was assessed.

vii. The achievement in chemistry while using the two modes of instruction in two different groups of students was analyzed using statistical techniques in order to find out the effectiveness of the model developed.

The evaluation of performance of students was carried out in different ways. The major focus was on evaluating the achievement of theoretical concepts. Two tests were used for this purpose. One test was administered as pretest and posttest to both experimental group and control group. The second test was prepared exclusively for the experimental group, focusing on the aspects of the industrial environment selected. This test was not administered to the control group students as they were not exposed to that industrial environment. The control group was taught using direct instruction.

An Observation Schedule prepared by the investigator was used for a formative evaluation of the skill in doing various activities like observation, recording of data, manipulating the equipments to the extent possible, communication with members of the staff and the like. Chemical processes and reactions were carried out in the laboratory, during the reflection session, to provide students with hands-on activities. A consolidated report of the observations made by the investigator, school teachers and the staff was recorded in the Observation Schedule.

6.2 Outcomes of the Study

The outcomes of the study can be presented in the following form taking into consideration all aspects of the study.

I. Apprenticeship-Type Learning (ATL) Model,

Based on the outcomes of the field studies, the **Apprenticeship-Type Learning (ATL) Model**, having four distinct phases of learning, was prepared as indicated below:

Phase I	Phase II	Phase III	Phase IV
Procedure design phase	Observation & Activity (ATL) Phase	Reflection and idea generating phase	Evaluation and extension

The four phases are arranged in an integrated and sequential manner. Each phase has definite objectives, series on learning events and evaluation procedures. Students were given a theoretical background of what is to be learned. They were then taken to the environment where they could learn while observing, doing, interacting and reflecting on the experiences gained. Students observed things, machines and equipments, their working procedures and processes adopted in the industry and thus developed cognitive as well as psychomotor skills. It proceeded with the assistance and guidance of the teacher and the staff. Thus in the ATL Model, students received a type of on-the-job learning. Apprenticeship-Type Learning (ATL) was found to be very effective in terms of the theoretical knowledge students gained and the performance skills they developed while constructing scientific concepts.

II. Apprenticeship-Based Learning (ABL) Model.

A generalized form of Apprenticeship-Type Learning (ATL) Model, named as Apprenticeship-Based Learning (ABL) Model, which can be used to learn subjects other than chemistry in appropriate learning environments. The difference between the two models is in the support system and also in the strategy for activity learning according to the nature of the environment selected.

III. Action Plan

An Action Plan suggesting better means for industry-institute interactions was prepared. The outcomes of the field studies and experimental study revealed the necessity of two things: the revamping of the school curriculum, in tune with technological and scientific advancements, by incorporating new models of teaching and learning and a positive change in the attitude of industries to allow the educational institutions to enter in and explore new strategies for teaching and learning.

6.3 Conclusions of the Study

Based on the outcomes of the study, the investigator arrived at the following conclusions:

Conclusion 1

The industrial environments were found to have high potential for imparting chemistry education at school level.

The content analysis of the HSS chemistry curriculum in relation to the structure analysis of industries showed that the concepts in all branches of chemistry could be learned leading to integration of varied topics. It was evident from the field studies also. Industries could be considered as learning centres capable of providing a sound base of varied experiences enhancing better chances for learning and training in chemical processes. The complexity and utility of chemical processes and products could be experienced directly.

Conclusion 2

The more the number of production units in a factory, the higher the opportunities for learning inter-related topics in the same context.

Even though the functions were almost mechanized, students had ample opportunities to observe, interact and reflect on the scientific and technological processes involved in different manufacturing processes. The chances for activity learning and constructive learning were very high. In the Aspirin Plant students were able to observe and learn about five different production units. They were able to identify the easily available resource materials for production purposes than those used in the laboratory, for example, the production of carbon dioxide from kerosene

Conclusion 3

> **Kerala, even though considered as an industry-phobic state, is blessed with the availability of many natural raw materials for manufacturing many industrial goods and materials.**

The presence of white sand of super quality in the Cherthala coastal area of Alappuzha district, deposits of oil in some area of Eranakulam district, mineral and metal deposits in the coastal area of Kollam district, white clay in Thonnakkal area of Thiruvananthapuram district, the black sand in the costal area of Alappuzha district, white shell of superb quality in the backwaters of Kottayam district are some examples for this observation. What we lack is the effective measures for extracting and utilizing these natural resources. In the cement factory, students identified the resource materials available in Kerala itself for the production of white cement. They were able to appreciate the presence of natural resources in our State; they were made aware of making use of these for the better functioning of industries.

Conclusion 4

The ATL Model was found to be more effective than Direct Instruction on students' achievement in chemistry.

The ATL Model was found to be more effective than Direct Instruction as evident from the comparison of achievement scores using ANCOVA (My.x is 17.827 for ATL and 12.2897 for DI; Fy.x = 185.7313 for df 1/117; $p<0.01$). The exposure to an industrial environment and learning through constructing ideas from activities, experiences and reflection enhanced the achievement of ATL group of students. They are provided with a wide variety of instances, processes and learning experiences that a classroom cannot provide.

Conclusion 5

ATL can help teachers in identifying and creating intellectual learning environments.

ATL was found to be meaningful as students were presented not only with subjectmatter but also with an environment where they could interact with subjectmatter and learn it on their own. The students were found actively engaged in the process of learning which developed in them certain powers of clear and vigorous thinking of coherent and logical deduction of exact and accurate observation. High posttest scores in the Achievement Test (II), ((Mean gain score = 12.6; CR is 28.0579; $p<0.01$) indicate the influence of the industrial environment on achievement in applied principles in chemistry. This influence was revealed in the Reflection Session also.

Conclusion 6

Apprenticeship-based learning model can be effectively used for any subject, outside the classroom, using appropriate learning techniques in suitable learning environments.

This idea was arrived at from the implementation of the ATL model. The major principles and sequence of learning events are applicable to many learning environments like Museums, Botanical Gardens, Zoos, etc., and majority of people involved in the study agreed to this idea.

Conclusion 7

Industries can provide pupils with opportunities to observe the application of chemical concepts in different contexts even for manufacturing the same product.

For example, cement is usually manufactured from lime shell and clay. But in a cement factory associated with the news print factory, cement is manufactured from fly ash, a waste material formed during the manufacture of news print. Pupils observed in the ASSC Ltd, a different process of production of Carbon dioxide i.e. from burning kerosene. In the Travancore Cements Ltd. pupils directly observed the manufacturing of cement using the wet process which is rarely used now-a-days.

Conclusion 8

Industrial environments can provide ample opportunities for development of social skills in children.

Interactions with factory people and reflections on the learning experiences made students think critically and creatively and generate ideas from experiences. A formative evaluation of skills during the implementation of the ATL Model also revealed this and shows chances of development in the affective domain.

Conclusion 9

An attitudinal change can be brought about in pupils towards the industries through ATL Model of learning.

An attitudinal change, in the positive direction, can be brought about in pupils towards the industries through ATL Model of learning. They, in turn, can make elders aware of the prospects and problems associated with the functioning of industries. The method of collecting resource materials, for instance the collection of white shell from the depths of Vembanad Lake, the mechanical processes involved in the working of mills and the kiln, the nature of skilled labour necessary for these processes, etc., for instance were observed by the students and this raised their curiosity to learn more. They wholeheartedly participated in the activities. Students carried out many industrial chemical processes in the laboratory in a simplified form and this helped to generate enthusiasm and confidence in working with industries.

6.4 Implications of the study

(1) In the 21st century higher education has a significant role to play in the content of globalization and market economy. Apart from content knowledge, professional skills, according to the nature of the courses, have to be developed in higher education-both professional and non-professional. All the results of the present study give a clear indication of starting developing those skills from schooling upwards. In the absence of these basic skills developed in schools, the much publicized aim of universities for the university-industry link became abortive.

(2) With a view to developing the basic professional skills in schools when the investigator prepared and tested the Apprenticeship-Type Learning (ATL) Model she found that the model was very effective not only for higher achievement in the subject but also for the development of the basic skills that are necessary for all technology based courses. So the authorities should introduce this model at school level forthwith to become innovative and creative in their courses in higher education.

(3) The authorities claim that the school curricula and the handbook prepared for teachers emphasize modern instructional strategies. Whether it may be true or not, in the actual transactions of the school curricula, the learning ends in memorizing the content. No attempt was made to use the education potential of the industries for learning.

The investigator studied the education potential of several industries and selected cement manufacturing factory for the learning of the topic 'Preparation and Properties of Cement, prescribed for higher secondary class'. The results of the industry based learning test showed a positive trend towards the development of the basic professional skills of the students. Since the development is gradual and slow the authorities should design a 12 year plan spreading over the entire period of schooling.

(4) The field studies conducted in Kerala State Salicylates and Chemicals (KSSC) Limited and Travancore Cements Limited show that educational institutions can make use of industrial environment for better instruction. From the analysis of the Chemistry curriculum and the field studies, it is clear that several areas of chemistry can be taught in collaboration with industries. The educational planners therefore can reorient the syllabus by providing more opportunities for school-industry relations.

(5) The country needs people with capacity to think independently, logically and critically and also to create knowledge. This need can be fulfilled if the ATL Model, based on constructivist learning theory, experiential learning and reflective learning, is introduced along with other modern methods for the teaching of all subjects. Students in their later life will be able to plan, organize and execute the field-related activities on their own, in co-ordination with other environments. This process of teaching and learning shall create an

urge to learn new developments, motivate and build up attitudes in the students to acquire information and knowledge about new techniques, modern developments and introduce them for improved performance. The Government may introduce this model at all levels from primary through secondary to tertiary levels of education.

(6) The study indicates that industry-institution interaction will bring a sense of realism to the instructional programmes of institutions. Continuing interaction between industries and institutions resulting in an unrestrained flow of information and resources will be for their mutual benefit and will lead to rapid growth and development. Interaction with industry in all aspects of curriculum process should be planned in such a way that the development of teacher in the subject matter, methodology of teaching and industrial orientation takes place in an integrated manner in a continuously changing environment.

(7) The **Action Plan** prepared by the investigator shows the road to prepare the instructional programmes based on apprenticeship. The plan suggests that curriculum should include academic programmes that are realistic and industry-oriented and must be developed as per the present and future needs, job opportunities and aspirations. The syllabi must be restructured gradually to adopt the latest theoretical and technical developments in science, engineering and technology. More emphasis should be made on practical vis-à-vis industry

requirements to make the students feel confident of what they have learned. This will help and encourage them for self- employment.

(8) All over the world, the manufacturing industry is undergoing a sea change: there is downsizing, there is outsourcing and there is new approach of managing industries. This requires human work force that can think of innovative ways of product design, product manufacturing and product marketing and organizing the entire gamut of industry running in different styles. The world will be looking for trained persons in all basic fields with sound knowledge base in their core discipline with abilities to adapt for new demands. This knowledge base can be effectively developed in the pupils from sound and efficient school-industry links, if the Government initiates to introduce Apprenticeship-Type Learning at all levels of education.

6.5 Suggestions for further research

For the absolute utilization of the Apprenticeship-Type Learning (ATL) Model, a large number of studies have to be conducted. Some of them are presented below:

The present study was confined to chemistry only. It can be repeated for learning other subjects.

The ATL Model can be tested for its effectiveness for learning many other topics in chemistry. This may lead to more and more utilization of the education potential of industries.

Studies can be conducted for the identification of education potential of many out-door learning environments suitable for different subjects at different levels of education.

The ATL Model can be compared with different modern instructional strategies to study the difference in effectiveness.

The outcome of a research project to identify the education potentials of all types of environments, for instance botanical gardens, industries, farming, dairy, could be of great help to teachers to select the appropriate environment (s) for students' learning using ATL.

As a precondition for the implementation of ATL, the basic skills required to be developed for higher education courses may be identified by undertaking a research project.

The investigator is of the view that the present study opens up many avenues for more studies that would, in future, contribute to innovative techniques in the field of science and technology education.