## CHAPTER III

# METHODOLOGY

- Chapter Preview
- Introduction
- Hypotheses formulated
- Objectives of the study
- Methods adopted for the study
- Tools and Techniques used for the study
- Sample for the study
- Research design
  - Pre-preparation of the ATL Model
  - Preparation of the Apprenticeship-Type Learning (ATL) model
  - Evaluation of the ATL Model
  - Formulation of a general form of ATL Model.
  - Preparation of Action Plan
- Statistical Techniques employed
- References

# CHAPTER - III

# METHODOLOGY

## 3.0. Chapter Preview

The chapter deals with the methodology of the study. The methodology is qualitative while the data analysis is quantitative. The main strategy for the present investigation is field study. Based on the analysis of the theories and models of teaching and on the outcomes of the field studies, the ATL Model is developed. The method adopted for the study, the experimental design, procedure and the statistical techniques employed for the analysis of data are described under appropriate sections.

## 3.1. Introduction

The topic for the study envisages the development of a model for Apprenticeship-Type Learning (ATL) in an industrial environment. By developing this model, it is intended to propose a learning environment where students are actively involved in the learning process. The environment means not only where instruction takes place but also the methods, materials, media and equipment needed to convey information and guide the learner's study. The teacher in this environment is a co-learner and facilitator in a collaborative nurturing atmosphere that facilitates high achievement by everyone. Learners are given opportunities to manipulate objects in real life situations (e.g., Factories or small scale industries); they generate ideas out of their experience and reflection. The education potential of an industrial environment is identified using strategies like field visit, structure analysis, content/ process analysis in connection with school chemistry curriculum at the higher secondary level.

Preparation of the Apprenticeship-Type Learning (ATL) model envisages its purpose and significance for classroom instruction and its effectiveness has to be determined experimentally. The existing model of teaching in the school is Direct Instruction (DI) where the teacher explains the subject matter given in a textbook. The investigator therefore plans to compare the effectiveness of both techniques of teaching – ATL and DI.

Since the topic selected for achieving this goal is *Cement*, prescribed for higher secondary students, it should be allocated for learning in an apprenticeship mode in a cement factory. In Kerala, it is a problem that how school and industry relationship can be established for learning as well as for improving the industrial enterprises in the future. In materializing this relationship, the following hypotheses and objectives are formulated for the study.

## 3.2 Hypotheses formulated

The Apprenticeship-Type Learning (ATL) model is developed, referring to the principles of constructivist learning. It is 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.

## 3.3 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 Chemistry education at school level
3. To determine 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)

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.

## 3.4 Methods adopted for the Study

The selection of the learning environment is an important and active part of the teaching /learning process. Constructivist learning requires the kind of flexible learning environment created, where teacher provisions teaching-learning process with tools that prompt students to organize and create knowledge (Mintzes et al, 1997). How we design and arrange instruction has a great deal to do not only with what is learned but also with how the learner uses what is learned. The relationship between information and environment can change depending on the instructional goal.

Pupils can construct meaning from simplified experiences involving actions and consequences. Thus the instruction/learning process involves the selection, arrangement and delivery of information in an appropriate environment and how the learner interacts with that information. The role of teacher is primarily to facilitate this by organizing and directing experiences which are matched with pupils' attainments and abilities. Thus a combination of theoretical and empirical methods was used for collecting relevant data for the study.

The study mainly used qualitative methods – relying on observation, field study and interview, analysis of written documents and narrative descriptions of processes or events. Observation is used to examine situations more closely and to evaluate the impact of interventions. It is someway a straight forward and easily understood way of collecting data. According to Nation (1997) naturalistic observation is a research method that permits the investigator to collect information in a naturally occurring environment. In field study students 'go into the field' to collect data directly through observation and/ or questioning. The interview method involves questioning or discussing issues with people. Field study was followed by interviews in order to get a more detailed perspective on some of the issues raised. The telling anecdote may be much more revealing and influential than almost any amount of figures.

The methods thus selected were in accordance with accomplishing the objectives which in turn will help in verifying the hypotheses of the study. The methods and techniques used for this are given below:

➲ 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.

➲ To develop the Apprenticeship-Type Learning (ATL) model:

A thorough analysis of

(a) the theories and principles of instruction, mainly based on constructivism, experiential and reflective learning

(b) the models of teaching /learning used at various levels

- To study the effect of ATL model on higher-secondary students' achievement in chemistry:

  Experimental method

- To identify the modes of interaction between school and industry:

  Interviews with personnel in the fields of industry and education.

Anyone of the methods or a combination of methods was used wherever necessary to arrive at dependable generalizations.

## 3.5 Tools and Techniques used for the Study

A good number of tools were found necessary for the collection of data required to test the hypotheses. The details regarding all these tools and techniques employed for the study are presented as given below:

**I. Data Analysis Sheet for Industries**

An industrial site is where a number of scientific and technological processes are going on leading to large scale production of goods and services. The details of all these processes cannot be comprehended by students at school level. Hence the investigator had to identify concepts that are to be learned by the students at higher secondary level. For this she prepared a Data Analysis Sheet for Industries to collect details regarding the industrial processes in relation to the chemistry education potential of industrial sectors, identified earlier. The details were collected and consolidated under the following heads:

1. Category of industry
2. Locality and features of the site
3. Divisions of production units
4. Raw materials used
5. Major products / byproducts
6. Technological devices used
7. Scientific processes involved
8. Products –uses and applicability
9. Type of pollution caused by the industry

. An expanded version of this Data Analysis Sheet (The General Performa) – including all details under each head – was provided for students to collect data during their field study.

**II. Lesson Transcripts Based on ATL Model**

The experimental group of students learned chemistry using the Lesson Transcripts Based on ATL Model. A model lesson is presented in Chapter IV and all lessons are presented as Appendix. C

**III. Observation Schedule - for assessing the Performance of the Students**

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.

**IV. Lessons for Direct Instruction**

The control group of students learned chemistry using the Lesson Transcripts for Direct Instruction. All lessons are presented as Appendix. I

**V. Achievement Tests in Chemistry**

An achievement test in chemistry (Achievement Test I – Content Achievement Test) consisting of 25 objective type questions was administered to the experimental and the control group as pretest and posttest. The test is presented as Appendix D.

Another test in chemistry (Achievement Test II-Industry based Learning Test) consisting of 25 objective type questions was administered to the experimental group only. The test consisted of questions regarding the processes and concepts dealt exclusively within the industrial environment. Only the experimental group was exposed to learning in the industrial environment. The test are presented as Appendix. F.

**VI. Informal Interviews - with people in the Field of Industry and Education**

Informal interactions with the authorities and staff of the school as well as industries are made to collect ideas regarding the ways and means for promoting school-industry link.

### 3.5.1 Validity and Reliability of the Data-gathering Devices

In this study different methods were used for gathering data in different contexts. Various tools and techniques were used and its validity and reliability are to be addressed.

#### *3.5.1.1 Content validity*

According to Best and Kahn (1989), content validity is based upon careful examination of course textbooks, syllabus, objectives and the judgements of subject matter specialists. The existence of content validity is often assessed by a panel of experts in the field who judge its adequacy, but there is no numerical way to express it. It is a matter of judgement rather than measurement (Kerlinger, 1986).

The above points were duly considered during content analysis of the HSS Chemistry textbook. A thorough analysis of the chemistry textbook was done to locate the industry-related topics that are to be learned. The identification of topics was made in relation to the sectors of industries selected for study. Consultation with people in the field of industry also helped in locating areas of study.

The content validity of the test administered was achieved by making professional judgements about the relevance and sampling of the contents of the test to a particular domain. Content validity will need to ensure several features of a test (Wolf, 1994): (a) test coverage - the extent to which the test covers the relevant field; (b) test relevance - the extent to which the test items are taught through, or are relevant to, a particular programme; (c) programme coverage - the extent to which the programme covers the overall field in question. It is concerned with coverage and representativeness rather than with patterns of response or scores. Maximum efforts were taken to ensure all these during the study.

***3.5.1.2 Curricular validity***

In the curriculum approach, which is actually a rational approach, it is assumed that the curriculum in the specific field as represented by textbooks, courses of study and expert opinion which is valid. The test content was compared with the course of study to determine its validity. For a more specific determination of curricular validity, a teacher, as the expert, examines his course outline and his teaching objectives to determine the degree to which they coincide with test content (Green, 1963. p. 84).

In the present study, the investigator analyzed the textbooks and resource materials in chemistry at the higher secondary level. The content was correlated with the industrial concepts relevant to the curriculum also. A number of industry-related topics were found, scattered in the syllabus. There are ample opportunities for field-based, direct and purposeful learning experiences but provision for the same was found to be lacking.

### *3.5.1.3 Construct validity*

Construct validity is achieved by ensuring that performance on the test is fairly explained by particular appropriate constructs or concepts. It is argued (Loevinger, 1957) that, construct validity is the queen of the types of validity because it is subsumptive and because it concerns constructs or explanations rather than methodological factors. The mental construct of the investigator who writes the test items determines the construct validity of the test.

In this study, the contextual and curricular aspects of the learning environment were taken into consideration while constructing the test items. Utmost care was taken in preparing the questions so that the students should easily understand what the investigator intended. The questions were made simple and straight in style keeping in view the extent to which particular constructs or concepts can give an account for performance on the test.

### *3.5.1.4 Concurrent validity*

Triangulation is a powerful way of demonstrating concurrent validity, particularly in qualitative research (Campbell & Fiske, 1959). It may be defined as the use of two or more methods of data collection in the study of some aspect of human behaviour. This study aimed at gathering qualitative and quantitative data and hence made use of different methods, for collecting valid data, as mentioned above. Field studies were supplemented by observations and informal interviews with people in the selected environment. The telling anecdote may be much ore revealing and influential than almost any amount of figures.

Further the more the methods contrast with each other, the greater the researcher's confidence. Thus concurrent validity was attained in this way and the investigator is confident that the data generated are not simply artifacts of one specific method of collection. It has been observed that as research methods act as filters through which the environment is selectively experienced, they are never atheoretical or neutral in representing the world of experience (Smith, 1991).

#### *3.5.1.5 Experimental validity*

An experiment has internal validity to the extent that the factors that have been manipulated (independent variable) actually have a genuine effect on the observed consequences (dependent variable) in the experimental setting. Internal validity is very difficult to achieve in the non-laboratory setting of the behavioural experiment, where there are so many extraneous variables to attempt to control (Best & Kahn, 1989). External validity is the extent to which the variable relationships can be generalized to other settings, other treatment variables, other measurement variables and other populations.

Green (1963, p. 85) suggested that the teacher who constructs his tests to fit his individual objective can expect higher validity from a standardized tests which merely approximate his objectives if the deviation becomes too great. Teacher made tests are designed for use with specific group of persons. Reliability and validity are not usually established. However more practical information may be derived from a teacher made test than from a standardized one because the test is given to the group for whom it was designed and is interpreted by the teacher/ test maker (Best & Kahn, 1989. p.213).

#### *3.5.1.6 Reliability*

It is suggested that reliability is a necessary but insufficient condition for validity in research: reliability is a necessary precondition of validity. An alternative form of reliability which is premised on a constructivist psychology emphasizes the significance of context, the importance of subjectivity and the need to engage and involve the testee more fully than a simple test (Cohen etal, 2000). There is a range of issues which might affect the reliability of the test like the perceived importance of the test, the degree of formality of the test situation, the way the test is administered, the amount of guessing of answers by the students, the way the test is marked, the degree of closure or openness of test items etc. Hence the researcher who is considering testing as a way of acquiring research data must ensure that it is appropriate, valid and reliable (Linn, 1993). Taking into consideration all the above points, steps were taken to make the study as valid and reliable as possible.

### *3.5.1.7 Objectivity*

Selection of industrial environments was done in an objective and specific manner and the tools for data collection were prepared accordingly. Tests used for evaluating achievement also were prepared after an objective and situation-specific analysis of the concepts to be learned. Observation of students' performance was done objectively within the constraints of the industrial environments. Interviews with personnel were conducted as informal as possible without attempting to probe into the confidential details of industrial processes. Thus steps were taken to make the data collection and analysis as objective as possible.

### *3.5.1.8 Practicability*

The practicability of the data gathering devices was highly specific with respect to the situation in which these were used. It was assured as far as possible by maintaining ease of administration, readiness of interpretation, economy in initial cost, proper scheduling of time, probability of securing materials, time required for scoring and analyzing the results.

## 3.6 The sample for the study

The present study made use of 170 higher secondary students (Std. IX), randomly selected, from two schools in two districts. The school-wise break-up of the sample is given below:

**Table 3.1**

**School-wise break-up of the sample**

| Group | Name of the school | No. of students | District |
|---|---|---|---|
| I | Muslim girls H.S.S., Kaniyapuram | 50 | Thiruvananthapuram |
| II | Catholicate H.S.S., Pathanamthitta | 120 | Pathanamthitta |

Three groups of students were formed for collection of information. Group I (N=50) was earmarked for field study in the industrial environment, Kerala State Salicylates and Chemicals (KSSC) Limited. The chemistry education potential of the industry for effective, contextual and experiential learning was found to be very high. This field study was taken as a pre-requisite to develop the Apprenticeship-Type Learning (ATL) Model.

After developing the model its effectiveness was to be tested. A second visit to the same plant was not possible due to some administrative problems. So it was decided that testing must be done in another place. Students in Group II (N=60) of the same standard were allocated to another industry, viz. Travancore Cements Limited, where they could 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. Sub samples are grouped based on sex only.

## 3.7 Research Design

The Research design includes the procedures used by the researcher to explore relationship between variables, form subjects into groups, administer the measures, apply treatment conditions and analyze the data. The selection of a research design usually involves a complex compromise involving what is most rigorous, what is most natural and what is possible. 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.

A diagrammatic representation of the research design for the present study is as given below:

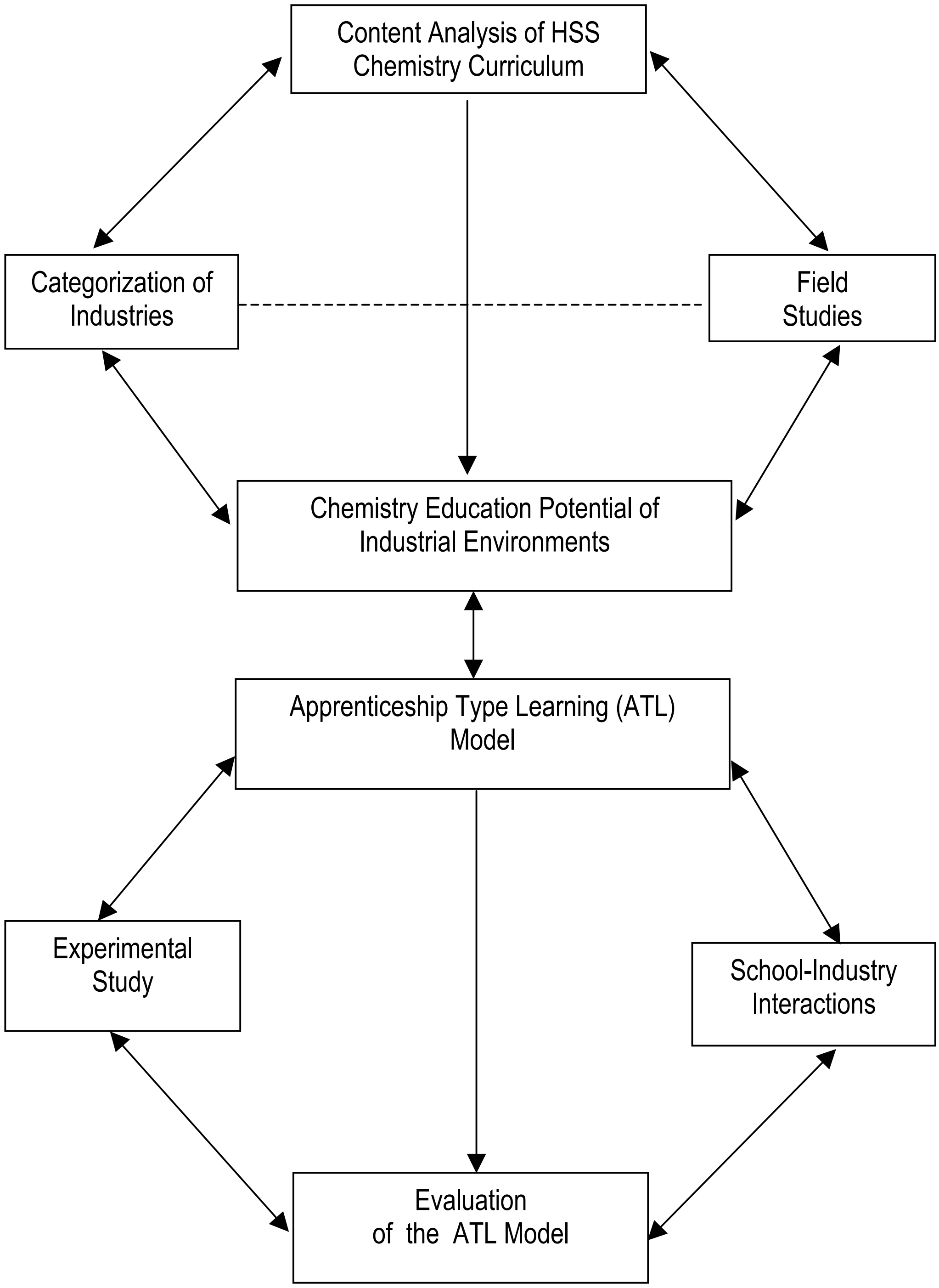


**Figure 3.1** **Research Design for the study**

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. The teachers' central task is to teach, powerful ways of knowing and doing, which can be applied out of school. Thus the procedure involved different stages in order to accomplish the different objectives which are presented in the following sections.

## 3.7.1 Pre-Preparation of the ATL Model

### *3.7.1.1 Introduction*

The most important aim of any model of teaching is to improve the instructional effectiveness through an interactive atmosphere. Vygotsky (1978) argued that "learning awakens a variety of internal, developmental processes that were able to operate only when the child is interacting with people in his environment and in cooperation with his peers". Some of the most effective learning takes place when teacher and student must seek answers together in a collaborative learning situation (Heinich et. al, 1993). During a constructivist learning experience, students have opportunities to become aware of the pre-existing ideas – they interact with materials, observe and then verbalize their inherent existing explanations for a phenomenon. Then they test and scrutinize their explanations, often modifying them and sometimes abandoning them.

### *3.7.1.2 Steps involved in Pre-preparation*

The pre-preparation stage of the ATL Model involved consultations with experts in the field of school education, higher education and technical education and in the field of industry for framing the sequence of learning events. The learning activities and situations were identified to develop various process skills like categorization, interpretation, discovering relationships and problem solving. In addition to this, situations were structured to develop cognitive, affective, psychomotor and social aspects. Thus the stage consisted mainly of the following three steps.

*3.7.1.2.1. Analysis of the existing theories and models of teaching and learning.*

*3.7.1.2.2. Identification of Chemistry Education Potential of some selected Industries.*

*3.7.1.2.3. Empirical verification of the chemistry education potential identified.*

Details of how the above steps were carried out are presented in Chapter IV, Theory and Preparation of ATL Model.

#### *3.7.1.2.1. 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 a lot in framing the learning sequences/events of ATL model.

### *3.7.1.2.2 Identification of Chemistry Education Potential of Industries*

The next step in the pre-preparation of the ATL Model was the identification of chemistry education potential of chemical industries in Kerala, which is the first objective of the study. It was conceived as a preliminary step for developing the Apprenticeship-Type Learning (ATL) model for learning chemistry in an industrial environment.

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. The stages involved are presented in the following sections:

#### *3.7.1.2.2.1 Selection of sites/ industries*

Site selection affects the viability of the whole study and great attention should be given to this process. Notes on an ideal site for naturalistic inquiry given by Marshall and Rossman (1989) are applicable here also. The ideal site is where

1. entry is possible
2. there is high probability that a rich mix of the processes, people, programs, interactions and / or structures that may be a part of the research question will be present
3. the researcher can devise an appropriate role to maintain continuity of presence as long as necessary and
4. data quality and credibility of the study are reasonably assured by avoiding poor sampling procedures.

Thus the site may or must be perfect for generalizability. Accessibility concerns geographic location and ability to gain entry and co-operation form the concerned authorities. Gaining entry into a possible site in an endeavor that must be well-planned and included in the site selection process. Gaining access to a suitable site will help very much in determining the focus of the study (Erlandson et al, 1993).

Any research involving changes or manipulation within an organization runs the risk of interfering with and undermining normal organizational processes, practices and procedures. Consequently, unless a study can guarantee minimal disruption, or unless there is a strong rationale for the study, it is unlikely that such research would be permitted.

In Kerala majority of the industries are run by the private or semi governmental agencies. They are very reluctant to admit people from outside into the factories. Public sector factories are not much conservative in this aspect, but well functioning factories are less in number in this sector. The investigator had to approach the authorities and officials many times to get permission to use the industrial environment for student learning. She had to find the best site possible within the boundaries of her resources.

It will be a tedious task to take all chemical industries functioning in Kerala and to find their education potential. Moreover it is not a major objective of the study to make such an elaborate attempt. Hence only those industries that are based on the chemical processes/ principles prescribed in the higher secondary school curriculum were selected for the study. These were categorized under different sections for easy and better analysis. Furthermore the data collected for the study were limited to the selected sites.

***3.7.1.2.2.2 Categorization of Industries***

The general information regarding the different sectors of industries functioning in Kerala was collected form the Industries Department, Govt. of Kerala, State Industrial Development Centers (SIDCs) and the Pollution Control Board (PCB). The various lists of industries categorized based on different criteria were obtained. General outlines regarding the functioning were also obtained. The investigator studied all these different aspects of industries and grouped them under different sectors keeping in view of the major products manufactured. While grouping them due representation was given for the products manufactured, utility and applicability of products, locality, significance and suitability for school-level learning. A list of factories under each sector is given as Appendix. A.

***3.7.1.2.2.3 Content analysis of the Textbook in Chemistry***

The content analysis was an essential component of this study in that it defined the independent variables against which the outcomes were correlated. In order to identify the chemistry education potential of industries at higher secondary level, it had become necessary to locate the industry-related topics in the curriculum. Topics which have direct relation to the industrial concepts are less, but industrial environments can be effectively used for learning topics related to the concerned industrial concepts. So during content analysis, these also were identified.

The investigator conducted this analysis in consultation with the supervising teacher, school teachers and other experts in the field of industry and education. At first the topics having direct relation to industrial preparation were identified. Then other topics that have relation to these major topics were analyzed. It was based on the assumption that an industrial environment can provide direct, purposeful and meaningful learning experiences for better learning and meta cognition. The topics identified were enlisted in Table. 4.3.

***3.7.1.2.2.4. Chemistry education potential of industrial environments***

The major industries/sites selected for the study were grouped into twenty different sectors (given in Table 4.2) on the basis of the major product of manufacturing. The content analysis of the textbook in chemistry helped in locating the industry–related topics and other allied topics and is presented in Table 4.3. A cross sectional analysis of these two groups of items based on the common concepts dealt with the industry and the school helped to identify the education potential of industries in Kerala. It gave a clear picture of the theoretical and practical aspects of the chemistry curriculum that can be learned from an industrial environment. The details are presented in Chapter: Analysis (Table 4.4).

***3.7.1.2.3 Empirical verification of the chemistry education potential identified***

A practical verification of the chemistry education potential of industrial environments was carried out before the preparation of the ATL Model. This was done first by the investigator, through field visit and structure analysis of selected industries, and then by taking students for field study. This helped in identifying the extent of use of an industrial environment for learning chemistry at school level and also the intricacies and constraints associated with learning in an industrial environment.

***3.7.1.2.3.1. Field Visit and Structure Analysis (Field study) of industries – By the Investigator***

A field study involves subjects behaving in their natural surroundings, but with the researcher actively manipulating aspects of the environment and noting the outcome (McQueen & Knussen, 1999).

Field visit, structure analysis and content/process analysis of industrial environments were carried out to collect information of three types:

i) Information of what exists – The major products of manufacturing, the process used for manufacturing, resources, usefulness of products, employment opportunities, etc., by studying and analyzing the aspects of the working industries for the teaching– learning process

ii) Information of what we want – The chemical principles and processes that can be learned from that environment, chemical concepts that can be developed and skills that can be acquired from the manifold activities in the environment; the study of interaction with the environment and the opinion of experts.

iii) Information of how to get - Discovering the possible means of achieving the objectives and goals on the basis of experience and reflection – i.e. development of scientific concepts and generating new ideas as far as possible.

**Importance of site visit/field study of industries**

Field visit provides firsthand observation and recording of events in specific environments. It helps to see how the science content is applied to specific processes and situation in a natural environment. The main purpose of the field visit was to analyze the structure and functioning of industries and the major processes used for production. It was necessary to locate these industrial concepts and processes in the school curriculum.

In order to make maximum use of the education potential of an industry, proper planning of learning activities is highly essential as the students are taken to an industrial environment where very complex operations and processes are carried out. It should be done well in advance, before students are taken for field study. It is not always possible for students to be released from school to experience an industrial environment. A preliminary visit to the industry willing to host the school students is, however, very desirable. It should involve a meeting with the person in the industry and will be useful for collecting details about

- The objectives and structure of the visit
- How the visit links with the curriculum, classroom work, and experience before and after the visit.
- The site in terms of what it manufactures, emphasizing the details of processes used and the nature of the products.
- Practicalities - date and duration, no. of students that can be accommodated, safety measures to be adopted and the like.

Once everything has been agreed, the students will need to be briefed about the industry and the purpose of the visit. It is good to prepare questions with the students prior to the visit to encourage them to talk to and engage in discussion with the people in the industry.

Thus prior planning of learning activities and strategies include - identifying the number of production units in the factory, the maximum number of students that can be accommodated in a unit at a time, the content areas that can be learned from the industrial processes, the mode of instruction that should be adopted during field study and the major learning activities that can be carried out for effective and meaningful learning. Extreme care must be taken while taking students for field study. Hence the field visit by the investigator was significant in framing and conducting field study for the students. Good planning will ensure that students' learning is not disrupted by other factors.

**Industries selected for field study**

From among the groups of factories given in Appendix A, a representative group of eight factories was selected for in-depth analysis and to identify the general information regarding the chemistry education potential of industries. The names of industries selected for the study are given in Table 3.2.

**Table 3.2**

**The Names of Industries Selected for Study**

| No. | Name of factory | Sector | Place |
|---|---|---|---|
| 1 | Travancore Titanium Products Limited | Chemicals | Kochuveli, Trivandrum |
| 2 | Kerala State Salicylates & Chemicals (KSSC) Limited | Pharmaceuticals | Thumpa, Thiruvananthapuram |
| 3 | Kerala Minerals & Metals Limited (KMML) | Minerals & Metals | Chavara, Kollam |
| 4 | Fertilizers and Chemicals, (FACT) Limited | Fertilizers | Ernakulam |
| 5 | Hindustan News Print Limited (HNL) | Paper &pulp | Kottayam |
| 6 | Malabar cements | Cement (Portland) | Walayar, Palakkad |
| 7 | Cochin cements Limited. | Cement (Pazzolona) | Kottayam |
| 8 | Travancore cements Limited. | Cement (White) | Kottayam |

**Criteria for selection**

A representative group of eight factories situated in five districts of Kerala was selected for field study. While selecting industries due representation was given to the products manufactured, the scientific processes involved in production, the emphasis of these processes in the school curriculum, the availability of factories for learning a particular topic, integration of different topics and the relevance and applicability of the knowledge gained in the practical life of pupils.

The above mentioned factories are selected for field study because they belong to the sectors of industries having many numbers of factories. Hence more number of students can be taken to these sites to learn the same topics. Moreover a large number of concepts included in the curriculum are related to the processes and products of these industries. Three factories producing cement, for instance, involve different types of processes of manufacturing to produce different types of cement. This helps in providing students with varied learning experiences on the same topic. Thus each industry represents a sector having wide chemical and industrial applications. The investigator made visits to these industries and conducted interviews with the concerned authorities.

**Structure analysis of industries**

The structure analysis of industrial environment was carried out based on the Input-Output Model (Khanna, 1994) which has three components as shown below:

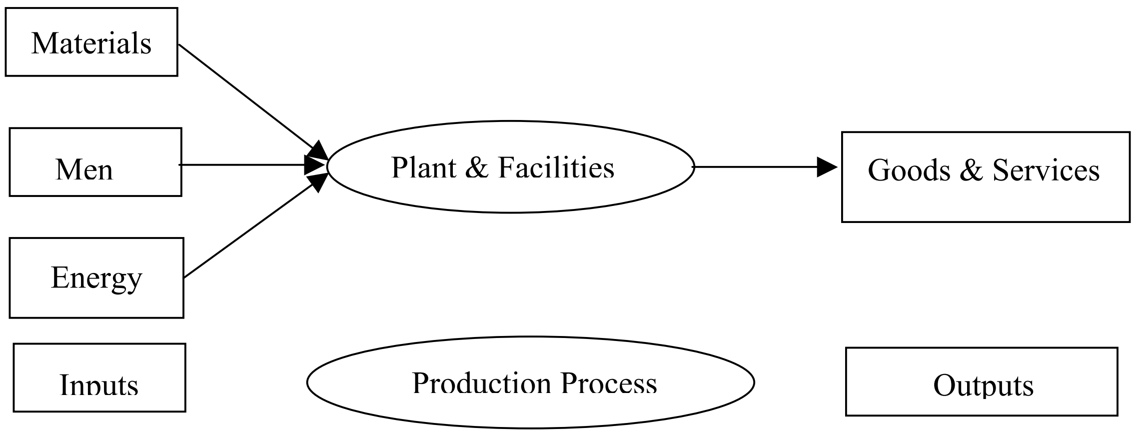


**Figure 3.2: Input-Output Model developed by Khanna (1994).**

The investigator conducted field study of all industries selected and prepared comprehensive reports as given in the Chapter IV. A Data Analysis Sheet, prepared by the investigator based on the Input-Output Model, was used for collecting details regarding the manufacturing processes.

During the industry visit, the investigator met the authorities in order to get firsthand information about the infrastructure of industries. A discussion with the officials helped her understand the possibilities of instruction of students in that particular environment. The details regarding the rules and regulations that are to be followed within that premises, the precautionary measures that are to be observed during instruction, the number of students that can be accommodated, the safety measures adopted, the time schedule that is to be followed without disturbing the daily routine work of factories and all necessary information were collected. An informal interview with the staff members also was used to collect relevant data.

The major products manufactured mainly were identified first. The production function involves a wide range of scientific processes and activities that have significance in the learning of chemistry at the school level. Knowledge of those gave an idea about the resources used for production, their ready availability and quality, processes used for preparation, purification, collection and nature and quality of the products. It made the purpose of structure analysis and process analysis of factories easier and helped in identifying the chemistry education potential of industries.

The major areas of chemistry prescribed in the chemistry textbook and related to the processes and products in the industrial field were identified. Care was taken to group the ideas related only to the higher secondary school curriculum; otherwise it may lead to excessive learning by students. The field visit needs to be recorded if it is to be of maximum utility in teaching (Gerlach et. al., 1980). Field study reports of six industries, prepared by the investigator, presenting the key points regarding their chemistry education potential is presented in Appendix. Elaborate reports of two industries (KSSC and Travancore Cements) were prepared as students are taken for field study in those industrial environments. These are presented in Chapter IV.

Thus maximum effort is taken to make the study as meaningful as possible. The details of analysis and interpretations were given in chapter IV.

#### *3.7.1.2.3.2 Field study of industries – By students*

Field studies by the investigator revealed that an industrial environment could provide students with varied learning experiences which are natural and meaningful to promote better learning and skills of reflection. Thus it was decided to take students for field visit and structure analysis of an industrial environment. The industrial site selected for the study was the Kerala State Salicylates & Chemicals (KSSC), Thiruvananthapuram. The details of structure analysis of the factory are presented in Chapter IV.

**Procedure**

Fifty higher secondary students of Muslim Girls High School, Kaniyapuram were taken for field visit to the KSSC Ltd. The visit was organized for two days and five teachers from the school accompanied the students along with the investigator. The investigator had sought admission for entry and administrative support for the study in advance. Students were given a general orientation regarding the industrial site. The rules and regulations to be followed in the factory units, the safety measures to be observed in plants during activities the procedure to be adopted for collecting relevant data, etc., were explained to students in detail. Precautions were taken to conduct the study as effective as possible without disturbing the daily routine work of the factory.

In order to make the collection of data easier and fruitful, the fifty students were divided into five groups designated as A, B, C, D, & E.

As there were five production units, each group was able to visit one plant at a time and rotation of groups helped in visiting all plants by all groups. Students in each group were asked to observe each and every detail of production-processes and activities involved and to record the events in consultation with the staff and the supervising teacher within a given period of time. They were motivated to work along with the staff to the maximum extent possible. The time allotted for learning in a plant was decided based on the nature of processes involved in production and their relevance in the curriculum.

The supervising teacher took special attention in directing students to observe and record the most relevant details only to avoid distraction in learning. Students were helped to make the recordings as precise as possible. Doubts of students were clarified by the staff and teacher whenever necessary. Students were provided with the Data Analysis Sheet (General Performa) prepared by the investigator for recording their observations and activities. The performa is given in Appendix B.

The General Performa was prepared based on the criteria for structure analysis mentioned elsewhere and was common for all students. The investigator took maximum effort to co-ordinate the activities of all groups in order to make the study as meaningful as possible. The teachers helped very much in managing the students, and the staff of the factory rendered selfless help in explaining the process in detail to students. Students also participated whole heartedly in observing and recording the events. The interaction between the staff and students was found to be satisfactory.

In an industrial environment, very huge technological devices are used for production and the majority of processes involved in production are done mechanically. Operations once performed manually are now largely performed through machines. Though the chance for students to get involved in the activities is less, many of those processes can be carried out in the laboratory in a miniature form. The basic principle involved or followed in the factory and the school might be the same, but the process planned commercially and the technological devices adopted in the factory have no comparison with those in a school laboratory. Nevertheless, the students' acquaintance with the production processes in a factory is expected to broaden their vista/horizon for their study in the future. Their interest and enthusiasm likewise would be sky-high.

After completing the two days' visit, the students were asked to prepare a report of their observations and activities in the factory. The reports were evaluated based on the chemical concepts derived from observation and activities. The achievement was found to be fairly high and the details of field study are given in Chapter IV.

#### *3.7.1.2.3.3 Outcomes of the field study*

The investigator analyzed the outcomes of the field visit of students to locate the advantages and disadvantages as well as deficiency in using industry as an outdoor learning centre. It helped in verifying the hypotheses of the study and in suggesting better means for using the chemistry education potential of an industry. The analysis revealed the utility of an industrial environment for chemistry learning, in many ways. The analysis also revealed some intricacies associated with learning in an industrial environment. The details are given in Chapter IV.

Taking into consideration the advantages of learning in an industrial environment and keeping in mind the difficulties that may arise while learning, it was proposed to develop a four-stage model for learning chemistry in an apprenticeship mode. Taking in view, the intricacies associated with learning in an industrial environment Apprenticeship-Type Learning is essential before actual, formal apprenticeship takes place. The on-the job learning experience will be of great help in the students' future life. It may provide good guidelines when they find job in industries as they will not be entirely new to the industrial working environment. Industry people also will not be worried about the handling of equipment by students as they assist and guide the students in their learning.

### 3.7.2 Preparation of the Apprenticeship-Type Learning (ATL) Model

#### *3.7.2.1 Introduction*

The development of a model of teaching/learning is the process of submitting an educational idea to repeated testing and refinement until the idea has matured to the point where fairly precise predictions can be made about how to use it and the effects to be expected if it is implemented well (Joyce & Weil, 1996).

The ATL Model is developed with a view to realizing the following goals:

- Developing alternative teaching methodologies to replace the traditional lecture demonstration format.
- Increasing the emphasis on importance of science in real world applications.
- Increasing the students' self-confidence in doing science.
- Increasing students' powers of reflection on the experiences gained
- Using strategies that enable students to consider ideas and evaluate alternative conceptions of observed/presented phenomena.
- Establishing strong School-industry relationships

The development of ATL model and its introduction for instruction is to advocate a real world connection and field work experience for pupils. The procedure adopted focuses on the major objectives of the study and the information gathered in the construction of strategies for obtaining successful results. Learning through ATL model is expected to increase the awareness level of students about industrial environments, their Chemistry education potential and the urgent need for better interaction between school and industry.

#### *3.7.2.2 Developing the ATL Model*

Developing a model can be seen as a search for a description or even a 'cause' for an observed fact, as constructing a design for something which does not already exist, or for developing a plan for an action. The use of an industrial environment as a learning centre showed that specific steps are to be adopted to teach students systematically. There are ample opportunities for having learning experiences which will contribute to the acquisition of new ideas through observation, experiences and reflection. This situation convinced the investigator the need for developing a model for learning Chemistry in an apprenticeship mode. It is also intended to make the teaching-learning process in Chemistry education life-oriented, activity-oriented, job-oriented, interesting and exciting.

A thorough analysis of the existing theories and models of teaching gave a clear idea regarding the key aspects and characteristics of a model for learning. 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. Consultations with experts in the field of school education, higher education and technical education and in the field of industry were made for framing the sequence of learning events. The learning activities and situations were identified to develop various process skills like categorization, interpretation, discovering relationships and problem solving. In addition to this, situations were structured to develop cognitive, affective, psychomotor and social aspects.

### *3.7.2.3 Description of the Apprenticeship-Type Learning Model developed*

The details of the model developed, the components including the syntax, and the steps involved in instruction are given in Chapter IV.

### *3.7.2.4 Preparation of Model lessons based on the ATL Model developed.*

The model lessons were prepared for learning the topic '***Preparation and properties of Cement'***, based on the ATL Model developed. For this the following procedure was adopted.

#### *3.7.2.4.1 Selection of a Site*

A suitable site or chemical industrial environment was located for learning the preparation of cement through the ATL Model developed. The Travancore Cements Limited was the industrial environment selected for the study.. It is the only cement factory in Kerala preparing *White Cement*. Even though the manufacturing process for ordinary cement and white cement are basically the same, white cement is an exclusive product having some notable qualities. By taking students to this factory, they will be able to observe and identify these qualities and experience the differences of this type of cement from ordinary cement in terms of production and uses.

#### *3.7.2.4.2 Planning of events*

Planning includes the selection of content to be included, selection of processes and skills to be practised and selection of activities which will allow the students to become familiar with the content and to practise the processes and skills. This selection is carried out at the syllabus or course level.

#### *3.7.2.4.3 Model lessons prepared*

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

The lessons are presented in the Appendix C and a sample lesson is presented in Chapter IV.

### 3.7.3 Evaluation of the model developed

Evaluation of the ATL Model developed was done on two mutually related aspects: effectiveness and usefulness.

#### *3.7.3.1 Effectiveness of the ATL Model – Experimental method*

After gaining insight into the literature related to the instructional strategies, theories of learning, models of teaching and the problem under study, the experimental procedures were executed. The effectiveness of the ATL Model developed was determined by using the experimental method which involves the random assignment of participants to conditions. If participants are randomly assigned to conditions, then any differences that appear after the experimental treatment are more likely to conform to cause-effect relationships.

The effectiveness of the ATL Model developed was evaluated in the following way

#### *3.7.3.1.1 Design of the Experimental Study*

Experimental designs, whether the experiment is conducted in a laboratory or in the field, involve the assignment of participants to conditions (Landy & Conte, 2004). Field studies permit researchers to study behaviours difficult to stimulate in a laboratory, but cause-effect relations are more difficult to examine in such field studies. The investigator adopted the Pretest – Posttest Parallel Group Design (Campbell & Stanley, 1963) with non-equivalent sample in the form of intact sections of class XI of the same school, for testing the effectiveness of the ATL Model.

The equivalent group design would have been a very comprehensive design of the experiment. But it was practically difficult in a school situation. In India, the school authorities are rather reluctant to allow the investigators to select students studying in different divisions, perhaps in different schedules, to form two equated groups. So it was decided to conduct the experiment in two non-equivalent groups, i.e. intact classroom groups. In order to compensate for the lack of equivalency, the technique of Analysis of Co-Variance (ANCOVA) was used for the calculation of the data obtained by conducting the experiment in the non-equivalent groups (Garrett, 1981).

Learning through ATL model, the experimental factor, was applied as treatment to one group and learning through direct instruction as treatment to the second group. The students were measured on the criterion variable, achievement in chemistry, before the treatment known as pre-test scores and just after the treatment on the same variable known as post-test measures, so as to determine the effect of treatment

**Table 3.3**

**Experimental procedure adopted**

| | | | |
|---|---|---|---|
| Group A (Experimental group) | Tested for knowledge of Chemistry (Pre-test) | Received instruction using ATL model | Posttest |
| Group B (Control group) | Tested for knowledge of Chemistry (Pre-test) | Received Direct instruction (DI) | Posttest |

### *3.7.3.1.2 Sample selected*

The experimental study was conducted on a sample of 120 students. Among them 60 students comprised the experimental group (learned using the ATL Model) and the other 60 students formed the control group (learned through direct instruction).

### *3.7.3.1.3 Variables*

Different kinds of variables in the study are as under:

**Independent variables/Treatment variables**

As the impact of ATL model on higher secondary students' achievement had to be studied, the method of instruction or teaching strategy in the form of ATL model and direct instruction were used as treatment variables. These were the treatment or antecedent conditions that were manipulated to study the effectiveness.

**Dependent variable**

The study focuses on enhancing students' performance by using different modes of instruction, the achievement of students was taken as the dependent variable. In this study, the achievement in chemistry of higher secondary students while using ATL model and direct instruction was studied.

**Confounding variables (Intervening / Extraneous / Uncontrolled Variables)**

Many variables are beyond the control of an investigator or could not be controlled due to many constraints though they might have an effect of the criterion variables. Some of these variables are socio-economic status, home environment, previous exposure to type of teaching, physical resources of the students, awareness of students regarding the concerned topics, time table schedule, time gap within treatment, fatigue, anxiety, enthusiasm and the like there remained uncontrolled during the experiment.

### *3.7.3.1.4 Instruction using ATL Model*

To be effective, teaching and learning must be systematic, i.e. what is to be learned, how it will be taught, and how learning will be measured, must be clearly defined and understood. Thus instruction using ATL model follows the systematic approach (Gerlach et al, 1980) as shown below:

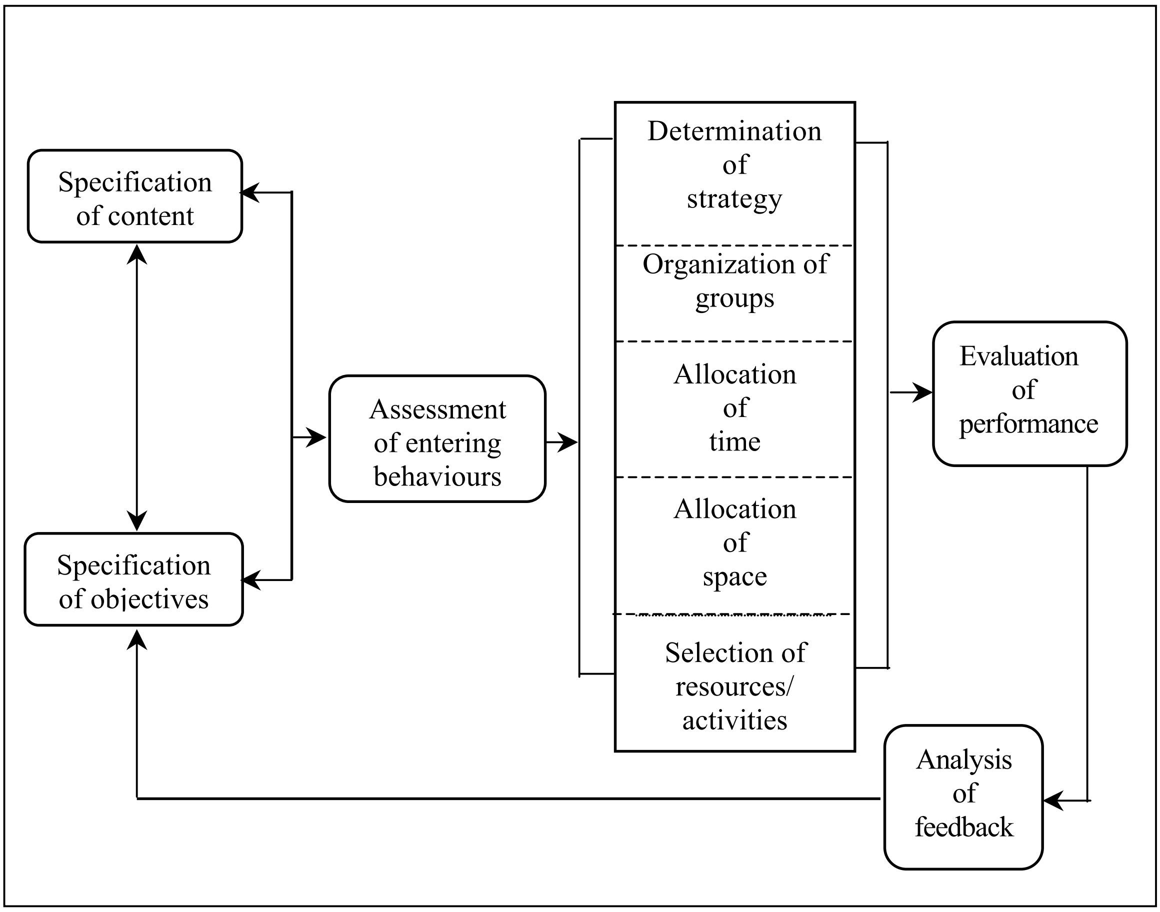


**Fig: 3.3. Systematic Approach to Instruction**

This diagrammatic representation is a guideline which shows the relationship of one element to another and it offers a sequential pattern that can be developed into a plan of teaching/ learning.

⊙ **Specification of content**

The selection of content is taken as a first step in instruction rather than specifying objectives, because ATL model aims at learning in a particular context (contextual / experiential learning). A specific learning environment in relation to the curriculum specified is selected first and then the areas that can be taught were identified. The objectives of instruction were formulated next.

Topic: Preparation and properties of Cement.

Context: The Travancore Cements Limited, Kottayam.

⊙ **Specification of Objectives**

Prior determination of objectives based on the selection of content is a minimum requisite for selection of instructional materials. Learning through ATL model was considered to be bringing about desirable changes in the following domains.

❖ <u>Learning in the Cognitive domain</u> **-** The classification of objectives in the cognitive domain proposed by Bloom (1984) envisioned a rather orderly progression from simple to complex mental abilities, as follows:

✈ Knowledge – recalling specifics, remembering, defining, recognizing, repeating.

- ✈ Comprehension – translating, interpreting, paraphrasing, summarizing, extrapolating.
- ✈ Application – using ideas and information.
- ✈ Creation – breaking down an example or system into its components; combining components to create a new product.

The categories proposed by Gagne (1988) include:

- ✪ Verbal/visual information
- ✪ Intellectual skills – the ability to use symbols to organize and manipulate the environment, involving discrimination, concept learning and rule using.
- ✪ Cognitive strategies – the internal control processes that govern the learner’s ability to visualize, think about and solve problems.

Thus the cognitive objectives pertain to the recall or recognition of knowledge and the development of intellectual skills and cognitive strategies

- ❖ <u>Learning in the affective domain</u> **-** It is impossible to think of any objective in the affective domain that is not related to one or several cognitive or psychomotor objectives; neither are there cognitive objectives which can be attained in an affective vacuum (Mager, 1968). The affective domain is organized according to the degree of internalization, or the extent to which an attitude or value has become part of the individual. The affective objectives pertain to interests, attitudes and values and the development of appreciations (Developed by Krathwohl and others, 1964).

❖ <u>Learning in the psychomotor domain</u> **-** Psychomotor means pertaining to the manipulative or motor skill area. The motor skill may be taken as one of the means which the pupil uses to manifest a cognitive ability. Attention to specific environmental stimuli during practice facilitates the learning of a motor skill. The teacher will do well to establish conditions which motivate students to improve their motor performance. Attention to specific environmental stimuli during practice facilitates the learning of a motor skill.

Categories of skills

- Acquisitive skills – Listening, observing, inquiring, gathering data, investigating, analyzing data, setting up experiments etc.
- Organizational skills – recording, comparing, contrasting, classifying, organizing, reviewing, evaluating, analyzing etc.
- Manipulative skills – Demonstrating, knowing and using instruments, describing parts and functions, illustrating scientific principles, experimentation, constructing simple equipments etc.
- Communicative skills – Asking questions (describing to some one else) clearly, classifying major points, exhibiting patience, being willing to respect), discussion (learning to contribute own ideas, listening to ideas of others, arriving at

conclusions), writing a report of an experiment or demonstration, constructively criticizing or evaluating a piece of work, a scientific procedure or conclusion, graphing the result of a study or experiment etc (Trowbridge & Bybee, 1996)

- ❖ <u>Learning in the social/interpersonal domain</u> **-** Singer and Dick (1974) have identified a fourth category of behaviour, i.e. in the social domain, in addition to the conventional cognitive, affective and psychomotor domain. The social domain, according to these authors, includes such bebaviours as "conduct, interpersonal relations, personal adjustment and emotional control and stability. Students learn how to co-operate within a group to reach goals, to compete effectively but with control, to demonstrate sportsmanship and to develop personal qualities that will encourage favorable interpersonal relations". Rackham and Morgan (1977) suggested the interpersonal domain where learning involves interaction among people. Interpersonal skills are people-centered skills that require the ability to relate effectively with others. It is assumed that this domain has certain appealing characteristics while using ATL model for learning.

The objectives of learning the topic 'Preparation of cement' is presented in the unit plan.

### ⊙ Assessment of entering behaviours

A significant reason for the measurement of entering behaviour is the necessity for an understanding of the learner's abilities and aptitudes. The fundamental question which must be answered prior to formal instruction is: “To what extent has the student learned the terms, concepts and skills that are part of this course of study?” A connection between the prior knowledge and new knowledge is an essential component of meaningful learning. For this the prior knowledge of the students is to be assessed. If there are deficiencies in the prior knowledge, these are to be compensated before new learning takes place. Preassessing learner’s needs is useful in planning remedial work for the pupils who lack the pre-requisite skills.

It is good practice to organize the course in units and administer a pretest before each unit. This procedure serves as a check on previous learning as well as a guide for the teacher and the student in planning future learning experiences. According to the feature of the environment chosen for study, various areas of knowledge will be invoked.

While using ATL Model for instruction, a pre-requisite test was made by the investigator. It was used for the testing of the awareness of the basic principles involved in chemical processes and concepts. This test was administered to the students. The deficiency in learning identified from this low percentage of answering was compensated while learning through ATL Model.

⊙ **Determination of Strategy**

The teacher/ investigator assumed the role of facilitator of learning experiences and arranged conditions in such a manner that students raise questions about a topic or event. The resources for finding answers or solutions were factual information collected through observation and reflection. The students raised questions about the content of the materials and attempted to organize the information and they were active participants in the learning processes.

**⊙ Organizing of students into groups**

The objectives of learning and the nature of the learning environment determine group size. Groups were decided based on the structure of the learning environment, opportunities for observation and recording of activities, chances for effective interaction among students, teachers and other people in the learning environment.

Thus the focus is on the rate at which students proceed through a carefully sequenced series of behaviourally defined objectives for each topic. It also involves the determination of how much exposure to content is required so that an individual pupil will achieve mastery of that content. It involves individual prescriptions for each student in the programme at each step in the learning sequence.

**⊙ Allocation of time**

Time is one of the conditions of the environment. Time in this context is the time taken by the students to complete their observations and activities in an effective way within the facilities of the industrial environment. The plan for use of time will vary according to subject matter, defined objectives, space availability, administrative patterns and the abilities and interests of the students. The teaching / learning plan takes into account the estimated time for each type of activity.

⊙ **Selection of resources/activities**

Factors affecting selection of activities are

- ♥ the pupil –knowledge base, interest, ability, aptitudes, etc.
- ♥ the instructional objectives – knowledge, understanding, application, skill and values objectives as well as social participation and social action
- ♥ the curriculum content – content emphasis, relevance and adaptability in the industrial environment, flexibility in organizing the learning activities, utility etc.
- ♥ the learning environment – physical arrangement, materials, availability of time, availability of materials, support from the administrators and staff etc.
- ♥ teacher competence
- ♥ the nature and complexity of activities

⊙ **Evaluation of Performance**

Performance is the focal point of learning. Performance is the interaction between the learner and the teacher, between learner and other learners, or between the learner and an instructional medium. It is during the performance that the stimuli are presented and responses are made. All the efforts that have gone into the formulation of objectives, the selection of content, and the assessment of entering behaviour gains significance or becomes more significant as the performance is evaluated. It is during the performance that certain aspects of learner development occur - motivation, practice, reasoning, transfer, re-enforcement and guidance of the learning activity.

Evaluation of performance was carried out in different ways while instruction using ATL Model. The major focus was on evaluating the achievement of theoretical concepts during ATL and two achievement tests were used for this purpose. Achievement Test I (Content Achievement Test) was administered as pretest and posttest to both experimental group and control group (Given as Appendix D). The Achievement Test II (Industry-Based Learning Test) was prepared exclusively for the experimental group (Given as Appendix F), 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. The achievement of students, in the concepts of chemistry learned, was evaluated from their scores and the scores were subjected to statistical treatments to identify the effectiveness of the ATL Model developed.

In the industrial environment, students have little opportunities to do manual activities and learn through individual actions. Huge technological equipments are used for production and students have little acquaintance with these equipments. Only skilled workers can handle those gadgets and they will not allow students to operate the machines. Moreover the factory people have to follow the safety measures to be adopted in various processes. Thus students' skill in doing scientific and industrial processes and activities could not be assessed in the industrial environment itself. Maximum efforts were taken to make the students involved in the activities.

Hence an Observation Schedule (Given as Appendix H), 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. As it was difficult for the investigator to record the evaluation of all students by herself, the assistance of the school teachers who accompanied the students and also the help from the staff were also sought. Consultation with staff members also was done regarding the performance of students. A consolidated report of these observations was recorded in the observation schedule. Thus the achievement of students in the development of skills was evaluated by identifying the extent to which they have developed the specific skills.

The details of analysis are presented in Chapter V.

The evaluation of performance on various learning environments can be used as a checklist for assessing the performance in that particular subject area. This can be used as a tool for continuous evaluation of performance in various fields of study.

⊙ **Analysis of feedback**

Feedback was collected from students at every stage of learning and maximum effort was made to rectify errors and misconceptions.

### *3.7.3.1.5 Direct instruction*

The direct instruction environment is one in which there is a predominant focus on learning and in which students are engaged in academic tasks a large percentage of time and achieve at a high rate of success (Joyce & Weil, 1996). Direct instruction refers to a pattern of teaching that consists of the teachers explaining a new concept or skill to a large group of students. Before presenting and explaining new material, it is helpful to establish a framework for the lesson and orient the students to the new material. Once the context for learning has been established, instruction can begin with the presentation of the new concept or skill. Presentation practices that appear to facilitate learning include:

- ♣ presenting material in small steps so that one point can be mastered at a time;
- ♣ providing many, varied examples of the new skills or concepts;
- ♣ modeling, or giving narrated demonstrations of the learned task;
- ♣ avoiding digressions, staying on the topic; and
- ♣ re-explaining difficult points (Rosenshine, 1985).

In this study a group of students (N=60) were taught through direct instruction. The following topics were selected for instruction and the plan for instruction was prepared (Given as Appendix I):

- Cement Industry in India.
- Types and compositions of cement.
- Manufacture and properties of cement.
- Manufacture and properties of Lime.
- Preparation and properties of Plaster of Paris.
- Preparation and properties of metallic Calcium.

The achievement of students was identified using the achievement test (Achievement Test I) in chemistry before and after learning through direct instruction.

***3.7.3.1.6 Experiment conducted***

The procedure adopted for conducting the experiment was as follows:

i. The experimental group students were taken to the industrial environment and allowed to learn through materials and activities based on the ATL Model.

ii. The students' achievement in chemistry was assessed before and after learning using appropriate techniques (pretest and posttest conducted).

iii. The same topic was taught to the control group students using direct instruction and their achievement in chemistry was assessed before and after learning.

iv. 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 identify the effectiveness of the model developed.

The details of the above procedures are given in Chapter V.

**Precautions observed**

Following precautions were observed during the course of the experiment (pretest - treatment - posttest) for ensuring effectiveness and high precision in experimental conditions which may have contributed to results:

- No undue stress or control of any kind was imposed on the subjects at any time during the study and the experiment was conducted in a relaxed natural setting.
- The effectiveness of the experimental treatment was ensured by establishing rapport with the people in the learning environment, maintaining natural setting, harmonious atmosphere, providing sufficient time for various activities in the experimentation and the like.
- It was ensured that the topics or contents of treatment had not been previously taught to the students and they have little acquaintance with the learning environment selected.
- Care was taken not to undermine the importance of content matter or the subject matter during the course of treatment - during observation and activity learning.
- Separate material and data sheets were provided for every student during experimentation so as to avoid any disturbance or chances of unfair observations.
- Separate and clear-cut direction was given to students for proper and secure means of data collection. Every step was taken to observe the safety measures in appropriate ways.

**Constraints and difficulties faced during the experiment**

It is necessary to mention some of the difficulties faced or constraints of the experiment for the knowledge of those who intend to conduct such researches in future. Such constraints of the experiment need to be taken note of are:

- It was a tedious task to convince the authorities of the industries the purpose of the study and to get permission for conducting the study. Many of them showed their inability or hesitation to permit due to administrative reasons.
- Some difficulty was faced during the preparation stage in orienting students about the activities in the learning environment. In the beginning the students were little hesitant to adjust to the requirements of the industrial environment and get involved in the activities but with the passage of time, the students began to take interest in the learning activities.
- Selection of suitable environment within the accessible distance from the school was a difficult task.
- It was another difficult task to convince the school authorities regarding the purpose of the study and the permission from the parents was also to be sought for taking students out of school.
- Arranging mode of conveyance, selection of the accompanying staff from the school etc were to be sought well in advance.
- Coordinating the activities of the factory staff, school staff and the students was not so easy. However the investigator took maximum effort to derive meaningful results out of these activities.

### *3.7.3.2 Usefulness of the ATL Model - Informal Interviews with People in the Field of Industry and Education.*

Opinion of personnel in the fields of school and industry regarding the usefulness the ATL model were collected during the implementation stage of the model. Informal interviews with the administrators and staff of the industries and the Pollution Control Board (PCB) helped in identifying effective and fruitful ways of using the industrial environment for effective learning at school level. Teachers and administrators in the schools, colleges and technical institutions were inquired about the feasibility of introducing apprenticeship-type learning for better education-industry links. The outcomes of these efforts were expected to reveal the usefulness of the ATL Model.

### 3.7.4 Formulation of General Form of ATL Model named Apprenticeship-Based Learning (ABL) Model.

The preparation and evaluation of the ATL Model showed that it is highly suitable for learning in an activity-oriented learning environment outside the classroom. The steps involved in learning through this model proved to be effective in developing cognitive and psychomotor skills. The interactions with people and learning materials in the learning environment provided students with opportunities to develop social and interpersonal skills. Thus the study indicated that well defined sequence of events involving observation, experience and reflection can be used to learn any topic/subject in an appropriate learning environment.

Thus a modified form of ATL Model is prepared to suit learning other subjects outside the classroom. The model is named as Apprenticeship-Based Learning (ABL) Model, focusing on the three main steps involved in the ATL Model. The phases of the ATL Model was modified to suit for learning any subject in an appropriate learning environment. They are described in Chapter V.

### 3.7.5 Preparation of Action Plan

The identification of the effectiveness and usefulness of the ATL Model necessitated formulating and implementing effective measures for improved school-industry links. Thus an **Action Plan** was prepared, suggesting better means for improving school-industry interactions, based on the recommendations of the personnel and the findings of the study.

## 3.8 Statistical Techniques employed

Since the aim of the experimental study was to test the effectiveness of ATL Model over Direct Instruction on achievement in chemistry, it is necessary to find out whether there is any significant difference between mean scores of pupils in the experimental and control groups. For this, the pre-test and post-test scores of pupils in the experimental and control groups were subjected to the following statistical techniques.

1) Mean
2) Median
3) Mode
4) Standard Deviation
5) Skewness
6) Critical Ratio
7) Analysis of Covariance

## References

Ashman, A.F. & Conway, R, N.F. (1994).***An Introduction to Cognitive Education.*** London: Sage Publications.

Best, J.W. & Kahn, J.V. (1989). ***Research in Education. (6th edn.).*** New Delhi: Prentice Hall of India.

Best, J.W & Kahn, J.V. (1995). ***Research in Education***. New Delhi: Prentice Hall of India.

Bloom, B. S. (ed). (1984). ***Taxonomy of Educational Objectives, Handbook I: Cognitive Domain.*** New York: Longman.

Campbell, D. T. & Fiske, D.W. (1959). Convergent and discriminant validation by the multitrait-multimethod matrix, ***Psychological Bulletin***, 56, 81-105.

Campbell, D. T. & Stanley, J. (1963). ***Experimental and Quasiexperimental Designs for Research on Teaching.*** Chicago: R and McNally.

Cohen, L et al. (2000). ***Research Methods in Education.*** London: Routledge.

Erlandson, D. A. et al. (1993). ***Doing Naturalistic Inquiry***. ***A Guide to Methods.*** London: Sage Publications

Fuller, A. (1996). Modern apprenticeships process and learning: some emerging issues. ***Journal of Vocational Education and Training***, 48(3). 229-248.

Gagne, R.M.; Briggs, L. & Wager, W. (1988). ***Principles of Instructional Design (3rd edn).*** New York: Holt, Rinehart and Winston.

Garret, H.E. (1981).***Statistics in Psychology and Education***. Bombay: Vakils, Feffer and Simons Ltd.

George,F. H. (1970). ***Models of Thinking***. London: George Allen and Unwin Ltd.

Gerlach, V. S. et al. (1980). ***Teaching and Media.*** New Jersey: Prentice Hall

Green, J. A. (1963). ***Teacher-made Tests***. New York: Harper & Row.

Heinich, R et al. (1993). ***Instructional Media and the New Technologies of Instruction.*** New York: Macmillan.

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

Joyce, B. & Weil, M (1996). ***Models of Teaching. 5th edn***. New Delhi: Prentice Hall of India.

Kerlinger, F.N. (1986). ***Foundations of Behavioural Research***. New York: Holt, Rinehart & Winston.

Khanna, O.P. (1994). ***Industrial Engineering and Management***. New Delhi: Dhanpat Rai Publications (P) Ltd.

Krathwohl, D. R et al (1964). ***Taxonomy of Educational Objectives – Handbook II: Affective Domain.*** New York: David Mckay.

Landy, F. J.& Conte, J. M. (2004). ***Work in the 21st century. An Introduction to Industrial and Organizational Psychology.*** New York: Mc Graw Hill.

Linn, R. L. (ed). (1993). ***Educational measurement. (3rd edn.).*** Arizona: American Council on Education and the Oryx Press.

Loevinger, J. (1957). Objective Tests as Instruments of Psychological Theory. ***Psychological Review***, 72, 143-55.

Mager, R F. (1968). ***Developing Attitude towards Learning***. Fearon: Palo Alto.

Marshall, C. & Rossman, G.B. (1989). ***Designing Qualitative Research***. Newbury Park: Sage Publications.

McQueen, R.A. & Knussen, C (1999). ***Research methods in psychology:*** A practical introduction. London: Prentice Hall Europe.

Mintzes et al (Ed). (1997). ***Teaching Science for Understanding. A Human Constructivist view***. London: Academic Press.

Nation, J. R. (1997). ***Research Methods.*** New Jersey: Prentice Hall Inc.

Oliver, R. (2000). Using new technologies to create learning partnerships. In Evans, T & Nation, D. (Ed). ***Changing University teaching – reflections on Creative educational Technologies.*** London: Kogan Page

Rackham, N& Morgan, T (1977). ***Behaviour analysis in Training***. London: Mc Graw Hill.

Rosenshine, B. (1985). Direct Instruction. In Husen, T. & Postlethwaite, T.N. (ed). ***International Encyclopedia of Education***. Vol. 3. Oxford: Pergamon Press.

Siddiqui, Dr. M Hasan (2004). ***Excellence of Teaching. A Model Approach.*** New Delhi: Ashish Publishing House.

Singer, R N. & Dick, Walter (1974). ***Teaching Physical Education – A Systems Approach.*** Boston: Houghton Mifflin Company.

Smith, H.W. (1991). ***Strategies of Social Research (3rd edn).*** Orlando: Holt, Rinehart & Winston.

Trowbridge, L. W. & Bybee, R W. (1996). ***Teaching secondary school science.*** New Jersey: Merrill.

Vygotsky, L. S. (1978). ***Mind in Society***. Cambridge, MA: Harvard University Press.

Yager, R. (ed). (1992). ***Curriculum Resource Handbook***. London: Merrill.

Wellington, J (1989). ***Skills and Processes in Science Education – A Critical Analysis***. London: Routledge.

Wolf, R.M. (1994). The validity and reliability of outcome measure. In Tuijnman, T.C. & Postlethwaite, T. N. (Eds). ***Monitoring the Standards of Education***. Oxford: pergamon, 121-32.