CHAPTER V

EVALUATION OF THE ATL MODEL

- Chapter Preview
- Introduction
- Effectiveness of ATL Model on learning Chemistry - Experimental study
- Usefulness of the ATL Model
- Formulation of a general form of ATL Model named as Apprenticeship-Based Learning (ABL) Model.
- Tenability of Hypotheses
- Preparation of an Action Plan.
- Conclusion

CHAPTER - V

EVALUATION OF THE ATL MODEL

5.0. Chapter Preview

This chapter deals with the evaluation of the ATL Model based on two aspects. The first one is the effectiveness of the model identified by comparing it with learning through direct instruction. The details of the experimental study conducted, the discussion of results and the tenability of hypotheses are presented in appropriate sections. The usefulness of the model, identified by collecting opinions of personnel concerned, is given in another section. Based on the effectiveness and usefulness identified, a general form of ATL Model named as ABL Model and an Action Plan for enhancing education-industry links are prepared. The details of all the above are presented as given below.

5.1. Introduction

Any model which is (metaphorically) interpreted as a representation of an observational or experimental reality should be exposed to some attempt at supporting this interpretation. The modes and feasibility of empirical validation vary greatly with respect to different contexts. Evaluation of the ATL Model developed was done on two mutually related aspects: effectiveness and usefulness.

An effective model can be useful as a basis for an action. Evaluation of the effectiveness of the model refers to a context-bound means-end analysis with respect to the specified problem: is the model likely to fulfil the specific purpose for which it was constructed? The evaluation of effectiveness is based on knowledge about the process of collection and recording of data, as well as knowledge from theories about the domain of interest. The theoretical and factual process of quantification is crucial to the effectiveness of the model.

The evaluation of usefulness includes a critical appraisal and evaluation of the purpose, of the criteria for an effective and efficient solution and of the intended, actual and possible consequences of the implementation or usage. The critical appraisal of the usefulness of the model is possible with respect to the factual context of usage.

Checking of the ATL Model comprised a comparison with other models and other descriptions, and theoretical results available. Experts in the field of education and industry were consulted with regard to the feasibility and practical utility of the model developed for instruction.

The details of the above mentioned procedures are given in the following sections:

5.2. Effectiveness of ATL Model on Learning Chemistry - Experimental study

5.3. Usefulness of the ATL Model

5.3.1. Formulation of a General Form of ATL Model named as Apprenticeship-Based Learning (ABL) Model.

5.4. Tenability of Hypotheses

5.5. Preparation of an Action Plan.

5.6. Conclusion

5.2. Effectiveness of ATL Model on learning Chemistry - Experimental study

Effectiveness of the ATL Model was determined using experimental method.

A sample of students (N = 60) of Std. XI learned the topic in chemistry, 'Preparation and properties of cement' using the ATL Model developed in an industrial environment. The same topic was taught to another group of students of the same standard using Direct Instruction (DI). The details of instruction using ATL Model and DI are given in Chapter III. The achievement in chemistry of students in both cases was determined using achievement test as pretest and posttest. The scores were compiled and subjected to statistical analysis, the details of which are presented in the following sections:

5.2.1. Instructional methods and student achievement in chemistry

5.2.1.1. Nature of posttest scores in achievement in chemistry of the experimental (ATL) and control (DI) groups.

5.2.2. Dependability of sample statistics: Confidence interval and variability of population.

5.2.2.1. Posttest scores of experimental and control groups

5.2.3. Genuineness of difference in performance of groups.

5.2.4 Effectiveness of ATL Model

5.2.5. Comparison of ATL Model of instruction with Direct Instruction in learning chemistry using ANCOVA (Total).

5.2.5. Comparison of ATL Model of instruction with Direct Instruction in learning chemistry using ANCOVA (Objective wise).

5.2.7. Comparison of ATL Model of instruction with Direct Instruction in learning chemistry using ANCOVA (Gender wise).

5.2.7.1. Comparison of ATL Model of instruction with Direct Instruction in learning chemistry using ANCOVA for male students

5.2.7.2. Comparison of ATL Model of instruction with Direct Instruction in learning chemistry using ANCOVA for female students

5.2.1 Instructional methods and student achievement in chemistry

In this section the scores of achievement in chemistry of the sample group of students are subjected to statistical analysis to see whether the results obtained from the experiment can be generalized for the population from which the sample was drawn. For this the measures of central tendency or position, measures of shape and measures of dispersion (spread) were calculated. This will help to describe a data distribution.

The statistical measures like mean, median, standard deviation, skewness and kurtosis were computed for the pretest and posttest scores in achievement in chemistry of the experimental and control groups to determine the nature and dependability of the sample statistics and to compare the scores of all the groups in the analysis. The maximum score in the achievement test was 25. The details of analysis are presented in the following sections

5.2.1.1. *Nature of posttest scores in achievement in chemistry of the experimental (ATL) and control (DI) groups*

The mean, median, mode, standard deviation, skewness and kurtosis of posttest scores of achievement in chemistry of the experimental (ATL) and control (DI) groups are given in Table 5.1.

Table 5.1

Measures of Central Tendency, Range, Dispersion, Skewness and Kurtosis of the Posttest Scores of Achievement in Chemistry of Experimental (ATL) and Control (DI) Groups.

Statistical Measures of Posttest Scores	Experimental (ATL)group	Control (DI) group
Mean	17.36667	12.75
Median	17.5	13
Mode	16	13
Range	12 – 23	6 - 19
Kurtosis	-0.10607	1.059538
Skewness	0.315604	-0.0657
Standard deviation	2.49723	2.404974

The mean and median of the groups are not having much difference. The median and the mode are very close to the mean, showing that the distribution of the scores is almost normal. Difference between the means is 4.616 showing significant difference in achievement in experimental group who learned using ATL Model. The low value of standard deviation shows the low dispersion of scores. The skewness is positive for the ATL group showing that the high scores obtained are less in number. The skewness is negative for the DI group indicating that the scores are massed at the upper end of the distribution.

5.2.2. Dependability of Sample Statistics: Confidence Interval and Variability of Population.

The dependability of the sample statistics for the posttest scores in achievement in chemistry of experimental and control groups was determined by computing the standard errors of mean and the standard deviation and by establishing the confidence intervals.

5.2.2.1 Posttest scores of experimental and control groups

The standard errors of the sample mean and standard deviation of the posttest scores of the control group (DI) and experimental group (ATL) were calculated. The mean, standard deviation, their standard errors and range of Mpop and SDpop of the posttest scores of experimental (ATL) and control (DI) group are presented in Table 5.2.

Table 5.2

Mean, Standard Deviation, Standard Errors and Ranges of Mpop and SDpop of the Posttest Scores in Achievement in Chemistry of Experimental (ATL) and Control (DI) Groups.

Statistical Measures of Posttest Scores	Experimental (ATL)group	Control (DI) group
Mean	17.36667	12.75
Standard deviation	2.49723	2.404974
SEM	0.322391	0.310481
SEσ	0.227965	0.219543
Range of Mpop	16.5349 - 18.19844	11.94896 - 13.55104
Range of SDpop	1.909081 - 3.085379	1.838553 - 2.971395

The figures given in Table 5.2. show that the ranges of Mpop and SDpop of the experimental and control groups at 0.99 confidence interval are narrow. It is obvious from this narrow range that sample means and sample deviations of the posttest scores in achievement in the experimental and control group are very much dependable.

Thus the findings of the analysis done for the nature and dependability of the achievement scores in chemistry obtained for the sample of the study are stable and dependable. This indicates the trustworthiness of the data collected from the sample. The results of the analysis of the test scores for the sample in chemistry achievement are applicable to the population of the study also.

5.2.3 Genuineness of Difference in Performance of Groups

The analysis of the posttest scores of pupils in the experimental and the control groups indicate that there is difference in the posttest scores of the experimental group and control group, showing that the experimental group has an edge over the other. Since the two groups selected for study were non-equivalent intact classroom groups, so the difference in the scores cannot be attributed to the effect of the experimental variable. Thus by mere comparison of posttest scores, it cannot be concluded that the experimental group differed significantly from the control group in their achievement.

In experimental research in schools, most attributes of students (such as achievement level, self-esteem, attitudes, and so on) are relatively stable before experiment. If we randomly assign students to different treatments without equating the students for different variables, barring the experimental variable and assess their achievement, it is likely that, no matter how powerful the treatment is, the scores might have been shadowed.

When the classrooms are selected for experiment, it is difficult to equate the experimental and control groups. "Through covariance analysis one is able to effect adjustments in final or terminal scores which will allow for differences in some initial variable" (Garrett, 1981, p.295).This problem can thus be overcome by the use of Analysis of Covariance (ANCOVA), in which the difference in the initial status of the two groups can be removed statistically so that they can be compared as though their initial status had been equated.

5.2.4 Effectiveness of ATL Model

The effectiveness of the ATL Model was determined by applying it in the experimental group. The mean, standard deviation and SEM and SEσ of the scores obtained by administering an achievement test were calculated. They are presented in Table 5.3.

Table 5.3.

Statistical Measures of the Achievement Scores of Students in the Experimental Group

Group	statistical measures	Maximum score of the test
Experimental group	M = 17.36667 σ = 2.49723 SEM = 0.322391 SEσ = 0.227965	25

The mean achievement score, 17.367 of the students for a maximum of 25, is appreciably high, showing that ATL is a very effective strategy for learning chemistry. The other measures given in the table also show that scattering of the score is not very high. But this result is not sufficient enough to conclusively determine the effectiveness. The investigator therefore compared the scores in the experimental group with those in the control group (using ANCOVA), where the Direct Instruction of teaching was tested.

5.2.5 Effectiveness of ATL Model and Direct Instruction (DI) - Comparison of Achievement Scores using ANCOVA

5.2.5.1 Comparison of the Achievement Scores in Chemistry of Pupils in the Experimental (ATL) and the Control (DI) Groups

In this part of analysis the total sums of squares, mean square variances and F ratios for the pretest and posttest achievement scores of the ATL group and the DI group were computed. The details of the analysis are given in Table 5.4

Table 5.4

Results of the Summary of Analysis of Variance of the Pretest and Posttest Scores of the Experimental (ATL) Group and the Control (DI) Group

Source of variation	df	SSx	SSy	MSx	MSy	Fx	Fy
Among means	1	21.6750	639.4080	21.6750	639.4080	15.29238	106.3902
Within Groups	118	167.2500	709.1837	1.4174	6.0100		

From the table, for df 1/118,

F at 0.01 level = 6.90

F at 0.05 level = 3.94

The obtained Fx value (15.2921) is higher than the table value at 0.01 level (6.90). It indicates that there is significant difference between the pretest achievement scores of the ATL group and the DI group at 0.01 level.

The obtained Fy value (106.3907) is higher than the table value at 0.01 level (6.90). It indicates that there is significant difference between the posttest achievement scores of the ATL group and the DI group at 0.01 level.

The total sums of squares and adjusted mean square variances for the posttest achievement scores were computed. The data are presented in Table 5.5.

Table 5.5
Results of the Summary of Analysis of Covariance of the Pretest and Posttest Scores of the Experimental (ATL) Group and the Control (DI) Group

Source of variation	df	SSx	SSy	SSxy	SSy.x	MSy.x	Sdy.x	Fy.x
Among means	1	21.6750	639.4080	-117.7250	814.3205	814.3205	2.0939	185.7302
Within Groups	117	167.2500	709.1837	181.1500	512.9785	4.3844		

From the table, for df 1/117,
F at 0.01 level = 6.90
F at 0.05 level = 3.94

The obtained Fy.x value (185.7313) is higher than the table value at 0.01 level (6.90). So there is significant difference between the ATL group and the DI group with respect to achievement at 0.01 level.

Comparison of Adjusted Mean Scores

The adjusted mean achievement scores for the posttest scores of students in the ATL group and the DI group were computed. The data are presented in Table 5.6.

Table 5.6

Results of the Test of Significance of Difference Between the Adjusted Means for the Posttest Scores in the Experimental (ATL) Group and the Control (DI) Group.

Group	N	Mx	My	My.x	SEDy.x	t
Experimental (ATL) group	60	3.8000	17.3667	17.8270	0.265411	20.86318
Control (DI) group	60	4.6500	12.7500	12.2897		

SE_D = 0.3823

From Table D for df 117,

$t_{0.01}$= 2.63

$t_{0.05}$= 1.98

Minimum difference required for significance at

0.01 level = 0.3823 X 2.63 = 1.0054

0.05 level = 0.3823 X 1.98 = 0.7570

Difference between My.x (adjusted) obtained = 17.8270 – 12.2897 = 5.5373. Since the difference between adjusted means (5.5373) is higher than the minimum required at 0.01 level of significance (1.0054), it is clear that this is significant at 0.01 level. The My.x (adjusted) value of the ATL group (17.8270) is higher than that of the DI group (12.2897). So it can be concluded that the ATL Model is better than the DI Method with respect to achievement at 0.01 level of significance. The probability of error regarding this result is less than one percent.

5.2.5.2 Comparison of the Achievement Scores in Chemistry of Pupils in the Experimental (ATL) and the Control (DI) Groups (Objective-wise)

The scores obtained by the students in the achievement test were consolidated objective-wise under different objectives like knowledge, understanding and application. They were analyzed statistically using the technique ANCOVA.

5.2.5.2.1. Comparison of the Achievement scores in Chemistry of Pupils in the Experimental (ATL) and the Control (DI) groups (Knowledge level)

In this part of analysis the sum of squares, mean square variances and F ratios for the pretest and posttest achievement scores, with respect to knowledge level of the students of the ATL group and the DI group were computed. The details of the results of the calculations are given in Table 5.7.

Table 5.7

Results of the Summary of Analysis of Variance of the Pretest and Posttest Scores of the Experimental (ATL) Group and the Control (DI) Group (Knowledge level).

Source of variation	df	SSx	SSy	MSx	MSy	Fx	Fy
Among means	1	3.0083	23.4083	3.0083	23.4083	6.0178	49.6992
Within Groups	118	58.9843	55.5834	0.4999	0.4710		

From the table, for df 1/118,
F at 0.01 level = 6.90
F at 0.05 level = 3.94

The obtained Fx value (6.0178) is lower than the table value at 0.01 level (6.90). But it is higher than the table value at 0.05 level (3.94). This indicates that there is significant difference between the pretest achievement scores, with respect to knowledge level, of the ATL group and the DI group at 0.05 level.

The obtained Fy value (49.6992) is higher than the table value at 0.01 level (6.90). It clearly indicates that there is significant difference between the posttest achievement scores, with respect to knowledge level, of the ATL group and the DI group at 0.01 level.

The sums of squares and adjusted mean square variances for the posttest achievement scores, with respect to knowledge level, were computed. The data are presented in table 5.8.

Table 5.8

Results of the Summary of Analysis of Covariance of the Pretest and Posttest Scores of the Experimental (ATL) Group and the Control (DI) Group (Knowledge level)

Source of variation	df	SSx	SSy	SSxy	SSy.x	MSy.x	Sdy.x	Fy.x
Among means	1	3.0083	23.4083	-8.3917	23.7303	23.7303	0.6863	50.3828
Within Groups	117	58.9843	55.5834	5.3000	55.1072	0.4710		

From the table, for df 1/117,

F at 0.01 level = 6.90

F at 0.05 level = 3.94

The obtained Fy.x value (50.3828) is higher than the table value at 0.01 level (6.90). So there is significant difference between the ATL group and the DI group in achievement, with respect to knowledge level, at 0.01 level.

Comparison of Adjusted Mean Scores

The adjusted mean achievement scores, with respect to knowledge level, for the posttest scores of students in the ATL group and the DI group are computed. The data are presented in Table 5.9.

Table 5.9

Results of the Test of Significance of Difference between the Adjusted Means for the Posttest Scores in the Experimental (ATL) Group and the Control (DI) Group (Knowledge level)

Group	N	Mx	My	My.x	SEDy.x	t
Experimental (ATL) group	60	1.75	4.4333	4.4475	0.08699	10.4814
Control (DI) group	60	2.0667	3.5500	3.5358		

$SE_D = 0.1253$

From Table D for df 117,

$t_{0.01} = 2.63$

$t_{0.05} = 1.98$

Minimum difference required for significance at

0.01 level = 0.1253 X 2.63 = 0.3295

0.05 level = 0.1253 X 1.98 = 0.2481

Difference between My.x (adjusted) obtained = 4.4475– 3.5358= 0.9117

Since the difference between adjusted means (0.9117) is higher than the minimum required at 0.01 level of significance (0.3295), it is clear that this is significant at 0.01 level. The My.x (adjusted) value of the ATL group (4.4475) is higher than that of the group (3.5358). So it may be concluded that the ATL Model is superior to the DI Method in achievement, with respect to knowledge level, at 0.01 level of significance. The probability of error regarding this result is less than one percent.

5.2.5.2.2. Comparison of the Achievement Scores in Chemistry of Pupils in the Experimental (ATL) and the Control (DI) Groups (Understanding level)

In this part of analysis the total sum of squares, mean square variances and F ratios for the pretest and posttest achievement scores, with respect to understanding level, of the ATL group and the DI group were computed. The details of the analysis are given in Table 5.10.

Table 5.10

Results of the Summary of Analysis of Variance of the Pretest and Posttest Scores of the Experimental (ATL) Group and the Control (DI) Group (Understanding level)

Source of variation	df	SSx	SSy	MSx	MSy	Fx	Fy
Among means	1	0.0080	53.3333	0.0080	53.3333	0.0128	41.3661
Within Groups	118	73.7837	152.1334	0.6253	1.2893		

From the table, for df 1/118,
F at 0.01 level = 6.90
F at 0.05 level = 3.94

The obtained Fx value (0.0128) is lower than the table value at 0.05 level (3.94). So there is no significant difference between the pretest achievement scores, with respect to understanding level, of the ATL group and the DI group at 0.05 level.

The obtained Fy value (41.3661) is higher than the table value at 0.01 level (6.90). It clearly indicates that there is significant difference between the posttest achievement scores, with respect to understanding level, of the ATL group and the DI group at 0.01 level.

The total sumS of squares and adjusted mean square variances for the posttest achievement scores, with respect to understanding level, were computed. The data are presented in Table 5.11.

Table 5.11

Results of the Summary of Analysis of Covariance of the Pretest and Posttest Scores of the Experimental (ATL) Group and the Control (DI) Group (Understanding level)

Source of variation	df	SSx	SSy	SSxy	SSy.x	MSy.x	Sdy.x	Fyx
Among means	1	0.0080	53.3333	-0.6667	53.5142	53.5142	1.1349	41.551
Within Groups	117	73.7837	152.1334	10.3334	150.6862	1.2879		

From the table, for df 1/117,

F at 0.01 level = 6.90

F at 0.05 level = 3.94

The obtained Fy.x value (41.5515) is higher than the table value at 0.01 level (6.90). So there is significant difference between the ATL group and the DI group in achievement, with respect to understanding level, at 0.01 level.

Comparison of Adjusted Mean Scores

The adjusted mean achievement scores, with respect to understanding level, for the post test scores of students in the ATL Model and the DI Method are computed. The data are presented in Table 5.12.

Table 5.12

Results of the Test of Significance of Difference between the Adjusted Means for the Posttest Scores in the Experimental (ATL) Group and the Control (DI) Group (Understanding level)

Group	Group	N	Mx	My	My.x	SEDy.x	t
Experimental (ATL) group	**ABL Model**	60	1.2000	5.4000	5.4012	0.14385	9.2852
Control (DI) group	**DI Method**	60	1.2167	4.0667	4.0655		

$SE_D = 0.2072$

From Table D for df 117,

$t_{0.01} = 2.63$

$t_{0.05} = 1.98$

Minimum difference required for significance at

0.01 level = 0.2072 X 2.63 = 0.5449

0.05 level = 0.2072 X 1.98 = 0.4103

Difference between My.x (adjusted) obtained = 5.4012– 4.0655= 1.3357.

Since the difference between adjusted means (1.3357) is higher than the minimum required at 0.01 level of significance (0.5449), it is clear that this is significant at 0.01 level. The My.x (adjusted) value of the ATL Model (5.4012) is higher than that of the DI Method (4.0655). So it may be concluded that the ATL Model is better than the DI Method in achievement, with respect to understanding level, at 0.01 level of significance. The probability of error regarding this result is less than one percent.

5.2.5.2.3. Comparison of the Achievement scores in Chemistry of Pupils in the Experimental (ATL) and the Control (DI) groups (Application level).

In this part of analysis the total sum of squares, mean square variances and F ratios for the pre test and post test achievement scores, with respect to application level, of the ATL group and the DI group were computed. The details of the analysis are given in Table 5.13.

Table 5.13

Results of the Summary of Analysis of Variance of the Pretest and Posttest Scores of the Experimental (ATL) Group and the Control (DI) Group (Application level)

Source of variation	df	SSx	SSy	MSx	MSy	Fx	Fy
Among means	1	8.0083	172.8000	8.0083	172.8000	15.8612	52.8424
Within Groups	118	59.5834	385.8667	0.5049	3.2701		

From the Table, for df 1/118,
F at 0.01 level = 6.90
F at 0.05 level = 3.94

The obtained Fx value (15.8612) is higher than the table value at 0.01 level (6.90). It clearly indicates that there is significant difference between the pretest achievement scores, with respect to application level, of the ATL group and the DI group at 0.01 level.

The obtained Fy value (52.8424) is higher than the table value at 0.01 level (6.90). It clearly indicates that there is significant difference between the posttest achievement scores, with respect to application level, of the ATL group and the DI group at 0.01 level.

The total sumS of squares and adjusted mean square variances for the posttest achievement scores, with respect to application level, were computed. The data are presented in Table 5.14.

Table 5.14

Results of the Summary of Analysis of Covariance of the Pretest and Posttest Scores of the Experimental (ATL) Group and the Control (DI) Group (Application level).

Source of variation	df	SSx	SSy	SSxy	SSy.x	MSy.x	Sdy.x	Fy.x
Among means	1	8.0083	172.8000	-37.2000	214.7669	214.7669	1.7065	73.7498
Within Groups	117	59.5834	385.8667	51.8667	340.7173	2.9121		

From the Table, for df 1/117,

F at 0.01 level = 6.90

F at 0.05 level = 3.94

The obtained Fy.x value (73.7498) is higher than the table value at 0.01 level (6.90). So there is significant difference between the ATL group and the DI group in achievement, with respect to application level, at 0.01 level.

Comparison of Adjusted Mean Scores

The adjusted mean achievement scores, with respect to application level, for the posttest scores of students in the ATL group and the DI group are computed. The data are presented in Table 5.15.

Table 5.15

Results of the Test of Significance of Difference between the Adjusted Means for the Posttest Scores in the Experimental (ATL) Group and the Control (DI) Group (Application level)

Group	N	Mx	My	My.x	SEDy.x	t
Experimental (ATL) group	60	0.8500	7.5333	7.7582	0.2163	13.1747
Control (DI) group	60	1.3667	5.1333	4.9084		

$SE_D = 0.3116$

From Table D for df 117,

$t_{0.01} = 2.63$

$t_{0.05} = 1.98$

Minimum difference required for significance at

0.01 level = 0.3116X 2.63 = 0.8195

0.05 level = 0.3116X 1.98 = 0.6170

Difference between My.x (adjusted) obtained = 7.7582– 4.9084= 2.8498

Since the difference between adjusted means (2.8498) is higher than the minimum required at 0.01 level of significance (0.8195), it is clear that this is significant at 0.01 level. The My.x (adjusted) value of the ATL Model (7.7582) is higher than that of the DI Method (4.9084). So it may be concluded that the ATL Model is better than the DI Method in achievement, with respect to application level, at 0.01 level of significance. The probability of error regarding this result is less than one percent.

5.2.5.3 Comparison of the Achievement Scores in Chemistry of Pupils in the Experimental (ATL) and the Control (DI) Groups (Gender-wise)

The scores obtained in the achievement test by the boys and girls were consolidated separately. They were analyzed statistically using the technique ANCOVA.

5.2.5.3.1. Comparison of the Achievement Scores in Chemistry of Boys in the Experimental (ATL) and the Control (DI) Groups (Gender-wise)

In this part of analysis the total sum of squares, mean square variances and F ratios for the pre test and post test achievement scores of boys in the ATL group and the DI group were computed. The details of the analysis are given in Table 5.16.

Table 5.16

Results of the Summary of Analysis of Variance of the Pretest and Posttest Scores of the Boys in the Experimental (ATL) Group and the Control (DI) Group

Source of variation	df	SSx	SSy	MSx	MSy	Fx	Fy
Among means	1	0.3590	480.1172	0.3590	480.1172	0.2383	80.5728
Within Groups	50	75.3333	297.9405	1.5067	5.9588		

From the Table, for df 1/ 50,
F at 0.01 level = 7.17
F at 0.05 level = 4.03

The obtained Fx value (0.2383) is less than the table value at 0.05 level (4.03). So there is no significant difference between the pretest achievement scores of boys of the ATL group and the DI group at 0.05 level.

The obtained Fy value (80.5728) is higher than the table value at 0.01 level (7.17). It clearly indicates that there is significant difference between the posttest achievement scores of boys of the ATL Model and the DI group at 0.01 level.

The total sums of squares and adjusted mean square variances for the posttest achievement scores were computed. The data are presented in Table 5.17.

Table 5.17

Results of the Summary of Analysis of Covariance of the Pretest and Posttest Scores of Boys of the Experimental (ATL) Group and the Control (DI) Group

Source of variation	df	SSx	SSy	SSxy	SSy.x	MSy.x	Sdy.x	Fy.x
Among means	1	0.3590	480.1172	-13.1282	508.0187	508.0187	2.0229	124.1401
Within Groups	49	75.3333	297.9405	85.6667	200.5230	4.0923		

From the Table, for df 1/49,

F at 0.01 level = 7.17

F at 0.05 level = 4.03

The obtained Fy.x value (124.1401) is higher than the table value at 0.01 level (7.17). So there is significant difference between the boys of the ATL group and the DI group with respect to achievement at 0.01 level.

Comparison of Adjusted Mean Scores

The adjusted mean achievement scores for the post test scores of boys in the ATL group and the DI group are computed. The data are presented in Table 5.18.

Table 5.18

Results of the Test of Significance of Difference between the Adjusted Means for the Posttest Scores of Boys in the Experimental (ATL) Group and the Control (DI) Group

Group	N	Mx	My	My.x	SEDy.x	t
Experimental (ATL) group	28	4.0000	18.1786	18.2734	0.256417	24.5099
Control (DI) group	24	4.1667	12.0833	11.9885		

SE_D = 0.5627

From Table D for df 49,

$t_{0.01}$= 2.69

$t_{0.05}$= 2.02

Minimum difference required for significance at

0.01 level = 0.5627 X 2.69 = 1.5137

0.05 level = 0.5627 X 2.02 = 1.1367

Difference between My.x (adjusted) obtained = 18.2734– 11.9885= 6.2849

Since the difference between adjusted means (6.2849) is higher than the minimum required at 0.01 level of significance (1.5137), it is clear that this is significant at 0.01 level. The My.x (adjusted) value of boys of the ATL Model (18.2734) is higher than that of the boys of the DI Method (11.9885). So it may be concluded that the boys of the ATL Model is superior to the boys of the DI Method with respect to achievement at 0.01 level of significance. The probability of error regarding this result is less than one percent.

5.2.5.3.2 Comparison of the Achievement Scores in Chemistry of Girls in the Experimental (ATL) and the Control (DI) Groups.

In this part of analysis the total sum of squares, mean square variances and F ratios for the pre test and post test achievement scores of girls of the ABL group and the DI group were computed. The details of the analysis are given in Table 5.19.

Table 5.19

Results of the summary of Analysis of Variance of the Pretest and Posttest Scores of the Girls in the Experimental (ATL) Group and the Control (DI) Group.

Source of variation	df	SSx	SSy	MSx	MSy	Fx	Fy
Among means	1	30.7484	203.0247	30.7484	203.0247	25.2181	37.3399
Within Groups	66	80.4722	358.8577	1.2193	5.4372		

From the Table, for df 1/ 66,
F at 0.01 level = 7.08
F at 0.05 level = 4.00

The obtained Fx value (25.2181) is higher than the table value at 0.01 level (7.08). It clearly indicates that there is significant difference between the pretest achievement scores of girls of the ATL group and the DI group at 0.01 level.

The obtained Fy value (37.3399) is higher than the table value at 0.01 level (7.08). It clearly indicates that there is significant difference between the posttest achievement scores of girls of the ATL group and the DI group at 0.01 level.

The total sums of squares and adjusted mean square variances for the posttest achievement scores were computed. The data are presented in table 5.20.

Table 5.20

Results of the Summary of Analysis of Covariance of the Pretest and Posttest Scores of the Girls in the Experimental (ATL) Group and the Control (DI) Group

Source of variation	df	SSx	SSy	SSxy	SSy.x	MSy.x	Sdy.x	Fy.x
Among means	1	30.7484	203.0247	-79.0106	270.9812	270.9812	2.1147	60.5951
Within Groups	65	80.4722	358.8577	74.0694	290.6817	4.4720		

From the Table, for df 1/65,
F at 0.01 level = 7.08
F at 0.05 level = 4.00

The obtained Fy.x value (60.5951) is higher than the table value at 0.01 level (7.08). So there is significant difference between the girls of the ABL Model and the DI Method groups with respect to achievement at 0.01 level.

Comparison of Adjusted Mean Scores

The adjusted mean achievement scores for the posttest scores of girls in the ATL group and the DI group are computed. The data are presented in Table 5.21.

Table 5.21

Results of the Test of Significance of Difference between the Adjusted Means for the Posttest Scores of Girls in the Experimental (ATL) Group and the Control (DI) Group

Group	N	Mx	My	My.x	SEDy.x	t
Experimental (ATL) group	32	3.6250	16.6563	17.2763	0.2681	17.5409
Control (DI) group	36	4.9722	13.1944	12.5744		

$SE_D = 0.5138$
From Table D for df 65,
$t_{0.01} = 2.66$
$t_{0.05} = 2.00$
Minimum difference required for significance at
0.01 level = 0.5138 X 2.66 = 1.36671
0.05 level = 0.5138 X 2.00 = 1.0276
Difference between My.x (adjusted) obtained = 17.2763– 12.5744 = 4.7019

Since the difference between adjusted means (4.7019) is higher than the minimum required at 0.01 level of significance (1.36671), it is clear that this is significant at 0.01 level. The My.x (adjusted) value of girls of the ATL Model (17.2763) is higher than that of the girls of the DI Method (12.5744). So it may be concluded that the girls of the ATL Model is better than the girls of the DI Method with respect to achievement at 0.01 level of significance. The probability of error regarding this result is less than one percent.

5.2.6 Performance of ATL Group Students in the Industrial Environment.

The experimental group of pupils was taken to an industrial environment for learning chemistry. While learning, they had a variety of learning experiences that a classroom cannot provide. In the cement factory, for instance, they observed different processes which are very complex and they were able to identify the manual and technical effort involved in the manufacturing processes. They were able to experience and learn the theoretical concepts in a wider perspective. So it is expected that the achievement of pupils in the ATL group may be more comprehensive than the pupils in the control group. The ATL group of pupils was having additional learning experiences than the DI group as they were exposed to the learning environment outside the classroom.

Thus the achievement of ATL group of pupils in the industrial environment was evaluated by using some tools other than the Achievement Test I (Content Achievement Test) which used as pretest and posttest for both experimental and control group. The following tools were used:

1. Achievement Test II (Industry-Based Learning Test) as pretest and posttest prepared based on the industrial processes.
2. An Observation Schedule for assessing
   - i). the performance skills of pupils,
   - ii) skill in recording of activities, and
   - iii) the nature of social skills like participation and interaction in the activities of the learning environment

The achievement test was administered to the pupils before and after the field study. The scores were consolidated and subjected to statistical treatment to identify the achievement of students based on the experiences in the industrial environment.

The observation schedule was used for a formative evaluation of the skills within the constraints of the industrial environment. The observation was done objectively and reliably to the maximum extent possible. The observations were recorded on a five point scale and the percentage of pupils under each category was identified. The ratings were assigned scores as 5 for excellent, 4 for very good, 3 for good, 4 for satisfactory and 1 for unsatisfactory. The ratings are complied and analysed accordingly.

5.2.6.1 Comparison of Pretest and Posttest Achievement Scores in Chemistry of pupils in the ATL Group using Critical Ratio

In this part of analysis the mean and standard deviation of the pretest and posttest achievement scores in Chemistry of pupils in the ATL model group were computed. The Critical Ratio was calculated and tested for significance. The data and result of test of significance are given in Table 5.22.

Table 5.22

Data and Results of Test of Significance of the Pretest and Posttest Mean Achievement Scores of pupils in the ATL Group

Test	No. of Pupils	Mean Scores	Standard Deviation	Critical Ratio	Level of Significance
Pre Test	60	4.1000	1.3626	28.0579	$P < 0.01$
Post Test	60	16.7000	3.2005		

The Critical Ratio obtained (28.0579) is significant at 0.01 level. This shows that there exists significant difference between the pretest and posttest mean achievement scores of pupils in the ATL Model group. As the mean score of the post test (16.7000) is higher than that of the pretest (4.1000), the performance of the pupils who learnt by the ATL Model is better in the posttest, the probability of error being less than one percent.

5.2.6.2. Comparison of Pretest and Posttest Achievement Scores in Chemistry of pupils in the ATL Group using Critical Ratio (Objective wise)

In this part of analysis the mean and standard deviation of the pre test and post test achievement scores in Chemistry, with respect to knowledge, understanding and application level of pupils in the ATL model group were computed. The Critical Ratio was calculated and tested for significance. The data and result of test of significance are given in Table 5.23.

Table 5.23

Data and Result of Test of Significance of the Pretest and Posttest Mean Achievement Scores of Pupils in the ATL Group

Test	No. of Pupils	Objectives					
		Knowledge		Understanding		Application	
		Mean Scores	Standard Deviation	Mean Scores	Standard Deviation	Mean Scores	Standard Deviation
Pre Test	60	1.9000	0.8505	1.1667	0.8199	1.0000	0.7071
Post Test	60	4.2333	0.7386	5.2000	1.3013	7.2333	2.2388
Critical Ratio		16.0449		20.3125		20.6111	
Level of Significance		$P < 0.01$		$P < 0.01$		$P < 0.01$	

The Critical Ratio (16.0449), which is significant at 0.01 level, shows that there exists significant difference between the pretest and post test mean achievement scores in Chemistry, with respect to knowledge level of pupils in the ATL group. As the mean score of the posttest (4.2333) is higher than that of the pre test (1.9000), the performance of the pupils who learnt by the ATL Model is better in the posttest, the probability of error being less than one percent.

The Critical Ratio (20.3125), which is significant at 0.01 level, shows that there exists significant difference between the pretest and post test mean achievement scores in Chemistry, with respect to understanding level of pupils in the ABL Model group. As the mean score of the posttest (5.2000) is higher than that of the pretest (1.1667), the performance of the pupils who learnt by the ATL Model is better in the posttest, the probability of error being less than one percent.

The Critical Ratio obtained (20.6111)is significant at 0.01 level. This shows that there exists significant difference between the pretest and posttest mean achievement scores in Chemistry, with respect to application level, of pupils in the ATL Model group. As the mean score of the post test (7.2333) is higher than that of the pretest (1.0000), the performance of the pupils who learnt by the ATL Model is better in the posttest, the probability of error being less than one percent.

5.2.6.3. Analysis of performance skills of ATL Group of pupils

The performance skills of students were evaluated from the scores of the ratings collected using the observation schedule. In the industrial environment pupils get limited chances for performing activities. Thus the emphasis is on collecting maximum details about theoretical concepts.

In the cement factory pupils observed the scientific and technological processes involved in the manufacturing of cement. After each session of learning in the industry, they prepared consolidated reports of learning in those sessions. The extent of performance of skills was being observed by the investigator and the teachers who accompanied the students. All these were recorded in the observation schedule.

In the laboratory, pupils conducted experiments to learn more about the chemical reactions involved in the preparation of cement. In the reflection session pupils elaborated the concepts learned in the industry using the lessons prepared based on ATL Model developed. Thus learning takes place, in different contexts using different strategies. In the classroom and in the laboratory pupils engage in discussion, doing experiments, and constructing ideas out of their experiences. The teacher acted as a facilitator and a guide in their activities.

All investigations must be summed up by making a record of what was done, what progress was made by the children and an overall evaluation of the success or failures of the study. Students were asked to prepare elaborate reports of their learning. A formative evaluation was found to more valid in this context. The reports are evaluated on the 5-point scale based on the evaluation of performance skills of students. A consolidated form of evaluation of performance skills and reports prepared by the students are presented in Table 5.24.

Table 5.24

Consolidated Scores and Ratings of Performance Skills and Reports of ATL Group of Pupils

No.	Performance skill scores	Skill in Report Writing				
		Excellent	Very good	Good	Satisfactory	Unsatis-factory
1	25		✓			
2	21			✓		
3	30	✓				
4	24		✓			
5	22			✓		
6	21			✓		
7	26		✓			
8	20				✓	
9	22			✓		
10	12					✓
11	25		✓			
12	23			✓		
13	21			✓		
14	31	✓				
15	19				✓	
16	22			✓		
17	23			✓		
18	12					✓
19	20				✓	
20	22			✓		
21	25		✓			
22	25		✓			
23	30	✓				
24	22			✓		
25	23			✓		
26	22			✓		
27	29		✓			
28	19			✓		
29	20			✓		
30	24			✓		
TOTAL		**3**	**7**	**15**	**3**	**2**

No.	Performance skill scores	Excellent	Very good	Good	Satisfactory	Unsatis-factory
31	23			✓		
32	26		✓			
33	30	✓				
34	23			✓		
35	21			✓		
36	24			✓		
37	20				✓	
38	20				✓	
39	22			✓		
40	26		✓			
41	20				✓	
42	13					✓
43	22			✓		
44	22			✓		
45	26		✓			
46	31	✓				
47	24			✓		
48	23			✓		
49	19				✓	
50	20				✓	
51	23			✓		
52	22			✓		
53	22			✓		
54	25		✓			
55	19		✓			
56	20				✓	
57	19				✓	
58	22			✓		
59	20				✓	
60	24			✓		
Total		**2**	**5**	**14**	**8**	**1**
Grand total		**5**	**12**	**29**	**11**	**3**

The Table reveals that the pupils who scored high for performance skills performed well in preparing their reports of learning.

5.2.6.4. Analysis of performance of social skills of ATL group of pupils

The observation schedule was used for a formative evaluation of pupils' interaction with people in the industrial environment. the rating were taken as an indication of performance of social skills of pupils. The ratings were consolidated and presented in Table.5.25.

Table.5.25

Consolidated Form of Ratings of Social Skills of ATL Group of Pupils

Part - III						
No	**Items**	**Excellent**	**Very good**	**Good**	**Satisfa-ctory**	**Unsatis-factory**
		No (%)	**No (%)**	**No (%)**	**No (%)**	**No (%)**
1.	Student involvement in learning	8 (13.3)	14 (23.3)	21 (35)	11 (18.33)	6 (10)
2.	Pacing of student in the activity	9 (15)	12 (20)	20 (33.3)	9 (15)	10 (16.6)
3.	Co-operation with the staff	9 (10)	15 (25)	23 (38.30)	12 (20)	4 (6.6)
4.	Co-operation with the fellow students in the group	13 (21.6)	19 (31.6)	23 (38.3)	5 (8.3)	--
5.	Discipline maintained	3 (5)	18 (30)	24 (40)	9 (15)	6 (10)

The Table reveals that performance of social skill of pupils was very much satisfactory. Only a very few pupils showed deviation from this and this can be attributed to the unfamiliarity to the learning environment.

5.3. Usefulness of the ATL Model

The ATL Model developed for learning chemistry in an industrial environment was found to be effective for learning as evident from the results of the experimental study. It was found to be more effective than direct instruction and the performance skills of pupils with regard to the learning in the industrial environment were good. Majority of pupils performed well in preparing reports of their learning. From this it was concluded that ATL Model is very effective for learning chemistry in an industrial environment. These out of class activities have greatly increased the students' interest in chemistry, improved their operational skills and reinforced their theoretical knowledge.

The investigator interacted with personnel in the fields of school and industry during the preparation and implementation stages of the ATL 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. Opinions regarding the usefulness the ATL model were thus collected.

The pupils are the first and foremost beneficiaries of ATL Model for learning in an industrial environment. So it is highly essential to collect their opinion regarding the utility of the model for learning. In the industrial environment pupils actively participated in the processes involved in production. They observed the working of huge technological gadgets and were able to experience production of large volumes of industrial goods. It was an entirely new experience for them. This motivated almost all students to participate in the learning activities. Pupils had not participated in industry-link activities in their secondary school curriculum. The analysis tried to determine any links between the pupils' current attitudes to industry and the means to enhance better school-industry link.

After field studies, they opined that the field studies have changed their concept about industries. The picture of an industry as an enterprise polluting the environment was transformed and a few students made comments on better means for collection of raw materials. For example, the dredging of white shell from the backwaters of Vembanad Lake was a new experience for students. They suggested that better means of waste disposal and management is necessary for preserving our environment.

The pupils were able to identify the links between science and industry, that industry is based on scientific knowledge, investigation and/or technologies. Only a few pupils responded negatively, commenting about science and industry producing pollution. Majority of pupils felt positive about the impact of industry on their lives. They acquired awareness about the jobs that are available within the industry and this may lead to aspire for an industry-related occupation in future. Their experiences in learning activities in the industrial environment may act as a decisive factor in the selection occupations in their future life. .

Teachers and the staff also rated the industrial visit high. They said that their experiences in the industry had been valuable and for preparing further teaching learning programmes. They appreciated the serious efforts taken to utilize the education potential of an industry to the maximum extent possible. They were all of opinion that the integrated sequence if events in the ATL Model can be used not only for learning chemistry but also for learning other subjects in suitable learning environments. Many teachers who were unable to visit industry suggested that active measures are to be taken for incorporating ATL Model for learning at HSS level.

Thus it was proposed to prepare a general form of ATL Model named as Apprenticeship-Based Learning (ABL) Model and an Action Plan for enhancing school-industry link.

5.3.1. Formulation of a General Form of ATL Model Named as Apprenticeship-Based Learning (ABL) Model.

The major focus of the study was developing a strategy for learning though a sequence of events involving observation, experience and reflection. The subject chosen was chemistry and hence an industrial environment was selected as the context for learning. The strategy commonly adopted for learning in an industrial environment is apprenticeship, mainly for professional and technical students. That is why it was proposed to develop the ATL Model.

Many studies have shown that learning environments outside the classroom like botanical gardens, museums, zoos, farms, aquariums, archives etc. has the potential for learning many topics. The steps involved in ATL can be effectively used for identifying the education potential of all these learning centres.

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 major difference between the two is in the support system and in the strategy adopted for learning. The provision for activity-oriented learning will decide the strategy that can be adopted for learning a particular topic/subject in a suitable learning environment.

5.3.1.1. Components of ABL Model

The components of ABL Model are the same as that of the ATL Model with a major difference in the support system. Depending on the nature of the support system, the principles of reaction and the strategies that can be adopted for utilizing the education potential of the support system can be changed. The major components of the ABL Model can be diagrammatically represented as given in Figure 5.1.

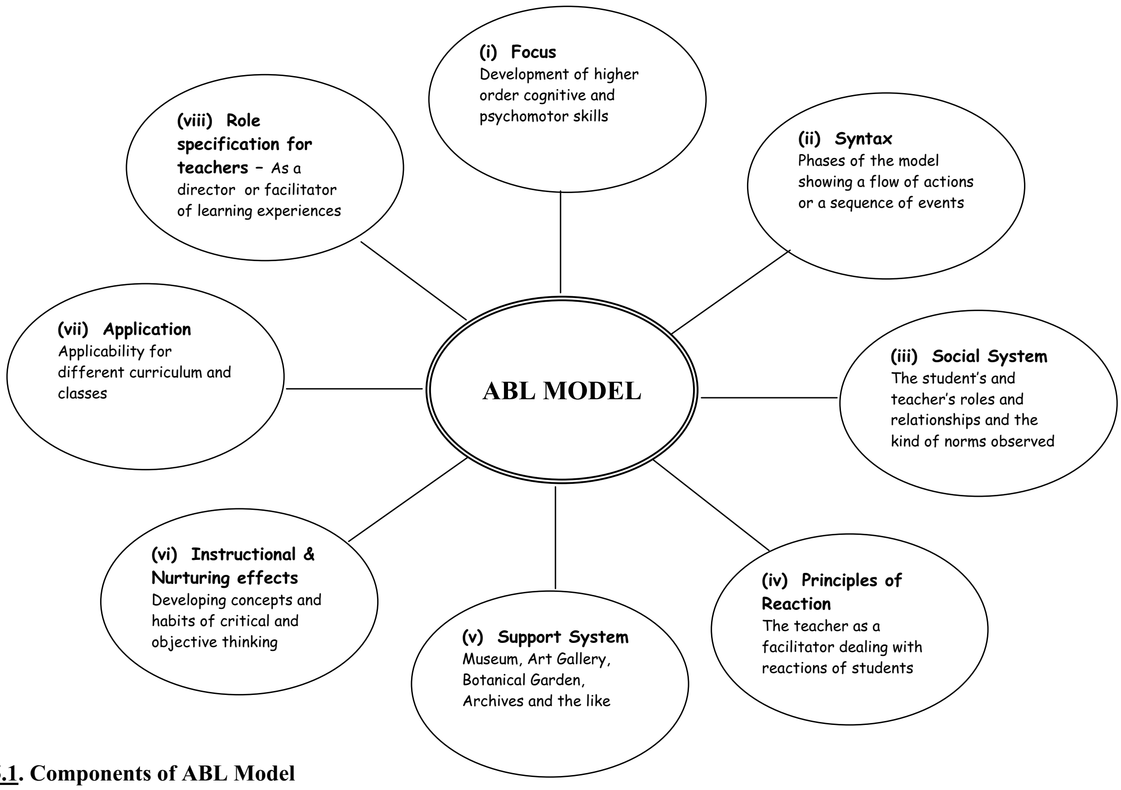


Figure 5.1. Components of ABL Model

5.3.1.2. The Phases of the ABL Model

The phases of the ABL Model are described as given in figure 5.2.:

Phase I ***Procedure Design Phase***

Major activities - (i) Preliminary Information.

(ii) Planning and Preparation for ABL

Phase II ***Apprenticeship-Based Learning (ABL) – Observation and Activity Phase***

Major activities- (i) Learning environment - observation by students

(ii) Learning through Appropriate strategies

iii) Checking the progress and recording of activities.

Phase III ***Reflection and Idea Generating Phase***

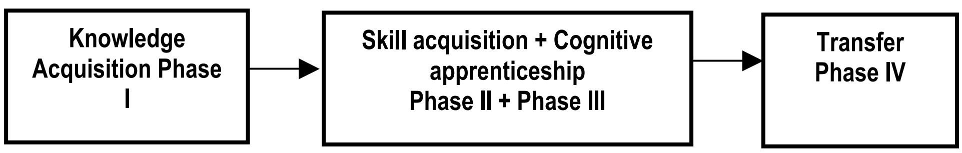
Major activities- (i) Discussion on student- record of activities

(ii) Rectification of errors and remediation

(iii) Conclusion and summary of learning

Phase IV ***Evaluation and Extension***

These phases in the strategy can be diagrammatically represented as



<u>Figure 5.2</u> The phases of the ABL Model

Phase I

Procedure Design Phase

While planning specific learning tasks, it is taken into consideration the following tasks.

1. Organization of students into groups – The objectives determine group size.
2. Allocation of time – the plan for use of time will vary according to the quantity of subject matter area, objectives, space availability, administrative patterns and the abilities and interests of students. The teaching plan should take into account the estimated time for each type of activity.
3. Discussion with students the objectives and expected learning outcomes – the handling in of work, behaviour codes etc.
4. Explain to students the nature of what is to be covered in a particular session and how this relates to the rest of their course.
5. Explain clearly (and review at intervals) the assessment procedure that will operate – this include both informal (critical used to monitor student progress) and the formal (externally imposed)

Students will be able to

(a) Articulate their learning needs

(b) Identify and discuss any learners which might prevent them from learning.

Phase II

Observation and Activity Phase

The earlier phase serves as a preparation for making empirical observations and the remaining phases focus on using those observations (ie. processing, understanding and communicating them). The strategy adopted for learning will depend on the nature and structure of the learning environment, the potential of the environment for learning, the content to be learned and the nature of students.

During this phase, instructional manipulation and learning experiences take place and proceeds through various stages of learning. It is the point/ phase at which students confront the content and begin to move towards the defined objectives. The focus is on the rate at which students proceed through a carefully sequenced series of behaviourally defined objectives (for each area). It also involves the determination of how much exposure to content is required so that an individual pupil will achieve mastery of that content. Individual prescription can be for each student in the programme at each stage in the learning sequence/ learning processes.

Phase III

Reflection on theLearning Experience – Idea Generating Phase.

This phase includes a period of review at the end of a lesson or activity in which pupils are debriefed about what they have learnt. Reviewing include asking pupils to review their own progress, and to identify aspects of their work, any difficulties they have encountered and what they feel they have learnt over the period being reviewed.

Once student's inferences are validated by data, the teacher can bring the lesson to a closure by verifying the abstraction, asking students to verbalize it, prepare a comprehensive note, on the concepts learned and by presenting additional examples to reinforce student learning. This enables pupils to assess their performance and learn from mistakes, and enables teachers to check whether their teaching has been successful. The theory classes should be arranged so that immediately after the practical session, the theory class is also covered in the same day which will give better and lasting effect on student's mind.

Phase IV

The final step in the implementation phase of the model is the presentation of additional data which directs towards transfer of learning.

Feedback

The concept of feedback used here implies a conformation or correction. The term is useful in instruction as it implies an evaluation of the product or terminal behaviour indirect relation to the original objective.

Internal Assessment forms an important part of the system of assessing student's performance during the course of study. It helps providing information to learners on their progress in learning as well as their achievement of the intended instructional objectives.

5.4. Tenability of Hypotheses

Hypothesis I

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

The first step in the study was the identification of chemistry education potential of industries in Kerala for learning chemistry at HSS level. The content analysis of the textbook of chemistry at HSS level revealed that many topics are related to industrial processes and preparations. A comparison of these with the different sectors of industries gave an idea about the education potential of various sectors of industries in Kerala.

Further field studies were conducted by the investigator and students for an empirical verification of the chemistry education potential identified. This effort convinced that there are ample opportunities for chemistry education at school level, thus the industries have the potential for chemistry education. Hence this hypothesis is proved to be true.

Hypothesis II

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

The practical verification of the chemistry education potential education of industries pointed towards the necessity for a suitable model of learning in industrial environment. For this a thorough analysis of the models and strategies adopted for learning at different levels of education was done. Taking into consideration of the aspects of utility of the industrial environments and the intricacies associated with this learning a four-stage model was developed, named as ATL Model, by incorporating the principles of constructivist learning, experiential learning and reflective learning. The model was used for learning the topic 'Preparation of Cement' in an industrial environment. The study revealed the effectiveness of the model for learning chemistry. Based on the results of the study, a general form of ATL model, named ABL model was also formulated. Thus this hypothesis is verified.

Hypothesis III

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

i). When a group of class XI students learned 'Preparation of Cement' using ATL Model developed in an industrial environment, their performance was appreciably high (Mean achievement score = 17.3667 for a maximum score of 25; Standard deviation = 2.49726; Range = 12-23).

ii). The effectiveness of the ATL model developed was tested by comparing it with another strategy of learning, Direct Instruction. The experimental study conducted showed that ATL model is more effective than DI on student's achievement in Chemistry (($M_{y.x}$ is 17.827 for ATL and 12.2897 for DI; $F_{y.x}$ = 185.7313 for df 1/117; $p<0.01$).

Hence this hypothesis is accepted.

5.5. Preparation of Action Plan

Development of and instruction using the ATL Model involved various stages and activities. At each stage the investigator as well as the students got ample opportunities to interact with people in the field of industry and education. The industry people were consulted regarding the means for improving school-industry interactions. This is an area which is explored very little and effective measures and restructuring are to be adopted in the education sector for enhancing school-industry interactions. The officials of the Pollution Control Board were interviewed to collect information regarding the nature of pollution caused by various categories of industries, better means of waste disposal and how educational institutions can help in reducing problems of pollution.

Experts in the field of education were consulted for preparing learning materials in industrial environments. Suggestions were also sought for making maximum use of the potential of industrial environments without affecting the working conditions. Personnel in the university and government level were enquired about the transformations that can be made in the academic level for enhancing industry-institute interactions. An Action plan was thus prepared, based on the effectiveness and usefulness identified, and is given below:

The **Action Plan** for enhancing school-industry links includes

1) The curriculum should include academic programmes that are realistic and industry-oriented and must be developed as per present

and the future needs, job opportunities and aspirations. This will promote the standard and quality of education and also the development of the industry.

2) The syllabi must be renovated 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. For this efforts must be made to increase interaction between the industry and the technical institutions.

3) An interaction between teaching institutions, research organizations and the industry has great relevance. The research institutions should collectively work towards the development of indigenous technology, import substitution and transfer of technology.

4) Effective exchange of knowledge and information between developed, developing and under developing industries and nearby educational institutions will help a lot in developing and increasing the effectiveness of ATL programmes.

5) Reduced political interferences will create conducive environment for better functioning and all-round development of productive sector. This will result in overall improvement in performance and accountability of industries which in turn may create more job opportunities.

6) Schools should provide students with opportunities for regular short visits to sites/industries. It should be a part of the education. The visits may create interest among the students in two ways – one, they will not be devoid of the routine class work and two, they will be exposed to practical solutions of the theories which they have learned or to be learned. Hence to understand the unsaid explanation such visits are useful. The short visits will also bring teacher and student closer to understand each other.

By taking above measures surely the education system can be improved and the system will produce the workforce coming up to expectation of the society.

5.6. Conclusion

It is important to orient the interest of learners towards the areas where chemistry will serve society and its development. Hence chemistry teaching should emphasize the experimental nature of the subject in order to ensure the acquisition of know-how, to give a practical sense and to develop the capacity for observation. ATL may lead to devising experiments which allow students to plan for themselves and which involve more than routine repetitive measurements. This may enhance student's enjoyment of experimental work and improve their attitude towards laboratory experiences. It should focus on observation and description of common chemical reactions and processes and the subsequent rationalization of what have been observed. ATL is expected to provide students with opportunities for learning in this manner.

Industry-institution linkages are an urgent need of the time to promote generation of suitable expertise and technologies and utilization of resources available. A proper interaction will provide an easy way to self employment, any of the major requirements for the developing countries like India. The Institute industry interaction is a process of credit transfer and must be flexible approach to match the changing global tendencies.

Thus in view of the fast changing technology, the survival of industries will largely depend on the quality of technical manpower and hence industries should try to invest a minimum time and energy to convert the students as useful resources for the industries. To be successful in this endeavor a high degree of interaction and co-ordination is essential from the various agencies like industry, institution, government and the students. Rapid progress in economic development is possible only if the industries and educational institution work hand in hand for industrial and manpower development.

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