THE EFFECT OF LABORATORY TRAINING MODEL OF TEACHING AND TRADITIONAL METHOD ON KNOWLEDGE, COMPREHENSION, APPLICATION, SKILLS-COMPONENTS OF ACHIEVEMENT, TOTAL ACHIEVEMENT AND RETENTION LEVEL IN CHEMISTRY

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ABSTRACT

The present study aimed at finding the effectiveness of the Laboratory Training Model of Teaching (LTM) and comparing it with the Traditional methods of teaching chemistry to seventh standard students. It strived to determine whether the (LTM) method in chemistry would be significantly more effective than the Traditional method in respect to the male and female students' overall as well as component-based achievement and retention in chemistry. Four homogenous groups of seventh standard students from two English medium primary schools in Mysore in India were selected adopting purposive sampling technique. Thirty students were selected from each class and hence 60 male and female students from school A and 60 from school B formed the sample of the study. Test of Higher Mental Ability in Science (THMAS) was used to determine the homogeneity of the participants. The 120 students of all the experimental and control groups were given the post-test at the end of the experimental work to both the experimental and control groups to measure their terminal behavior. The researcher-constructed and validated achievement test of chemistry was administered to the subjects in experimental and control groups at the end of the instruction to measure their achievement in chemistry. After a gap of one month, the delayed post-test for achievement in chemistry was administered to the experimental and the control groups to determine the retention level of the students. The statistical technique used to analyze the obtained research data was the independent sample t-test. The findings of the study indicated that as far as the overall achievement and retention in chemistry is concerned, the (LTM) method of teaching chemistry were much more effective than the Traditional method. As for the components of achievement and retention: comprehension, application, and skills in chemistry, the (LTM) method was more effective than the Traditional method except knowledge component. But the component of knowledge in achievement and retention in Traditional method was more effective than (LTM) method in chemistry.

Keywords: Laboratory Training Model of Teaching (LTM), Traditional method, Achievement level, Retention level.

INTRODUCTION

It is hard to imagine learning to do science, or learning about science, without doing laboratory or field work. Experimentation underlies all scientific knowledge and understanding. Laboratories are wonderful settings for teaching and learning science. They provide students with opportunities to think about, discuss, and solve real problems. Developing and teaching an effective laboratory requires as much skill, creativity, and hard work as proposing and executing a first-rate research project. Typically, students work their way through a list of step-by-step instructions, trying to reproduce expected results and wondering how to get the right answer. While this approach has little done with science, it is common practice because it is efficient. Laboratory Training Model of teaching is a method that focuses on the first hand information which comes from research and laboratory. In this method nothing is directly taught, but the learning situation and condition are provided, so that the learners themselves find the solution to the problem. In other words,

Laboratory Training Model of teaching is an activity in which the learner practically experiences a specific concept with specific materials and equipments (Shabani, 2002).Laboratory Training Model of teaching varies widely, but there is certainly no substitute for an instructor circulating among the students, answering and asking questions, pointing out subtle details or possible applications, and generally guiding students' learning. Although students work informally in pairs or groups in many labs, some faculty has formally introduced cooperative learning into their labs. Some instructors rely on a lab handout, not to give cookbook instructions, but to pose a carefully constructed sequence of questions to help students design experiments which illustrate important concepts (Hake, 1992).One advantage of the well-designed handout is that the designer more closely controls what students do in the lab (Moog and Farrell, 1996). The challenge is to design it so that students must think and be creative. In more unstructured laboratory Training Model the challenge is to prevent students from getting stranded and discouraged.

The purpose of the Laboratory Training Model of teaching is to help materialize the characteristics of events, materials, analysis, synthesis, evaluation and recreating the materials and events and also the relationship between them. A laboratory is a suitable place in which the materials are learned through discovery learning, problem solving. This method can be mixed with other methods like group learning, discovery learning and so on. Laboratory learning can increase the quality of learning and is an incentive in a learning activity. This method is very much suitable for satisfying the sense of inquisitiveness, improving the power of exploring, raising learners' critical thinking, building self-confidence and also self -satisfaction.

Laboratory activities help to solve problem. In Laboratory Training Model of teaching learner faces with some problems tries to solve those problems by using available facilities to find the solution. In a laboratory learner gets an opportunity for experimentation and for logical thinking. Their participation in group discussion also contributes to his social growth during the process of experiment. Many concepts rules and principles of chemistry could be effectively taught by conducting experiments.

Research in teaching through Laboratory Training Model of teaching in order to improve the process of teaching and learning is a necessity. It makes the educational process into a learner centered one and gives the pupil the joy of discovery and thus motivates him for further learning.

Traditional Method of Teaching

Traditional teaching method is teacher-centered activity in which teacher imparts knowledge and students passively receive it. The teacher's presence is very important in the whole process and he or she has an authoritative and unassailable role in the class (Rajput, J.S. (1997). In the traditional classroom teaching-learning environment, there is face-to-face interaction between the teacher and the students. In this environment, data would be introduced to the class in the form of a lecture that would make use of teaching aids like white boards and handouts. The teacher would try to explain the concepts to the students, work out examples and set practice exercises to be done in class and for homework. During a class session the students have the opportunity to ask questions on what they do not understand. When the students do the exercises in the class the teacher is available to help them out of their difficulties on the spot. However, when students do the home work exercises and encounter difficulties, they may have to wait until the next class to get the teacher's assistance.

However the traditional teacher centered method is largely practiced in schools, the main technique which is used in traditional method is "lecturing", through which the information is transferred from teacher to learner and the emphasis is on what the learner retains. The teacher teaches in lecture method and teaches in detail and asks the learner to take note from what he says. In fact the learner is just a spectator. Here the teacher is active and the learners are passive listeners. In this method more teaching happens rather than learning. Since emphasis is on what the learner retains. The teacher does not motivate learners to participate in class discussion. In such class the most active sense is hearing and learner gets more and more dependent on the teacher. The traditional method does not fill the curiosity of the learners and does not contribute to build their self confidence. It doesn't encourage them in

discovering and inventive thinking and then does not contribute to maximum learning and retention.

Bloom's Taxonomy is a wonderful reference model for all involved in teaching, training, learning, coaching - in the design, delivery and evaluation of these development methods. At its basic level, the Taxonomy provides a simple, quick and easy checklist to start to plan any type of personal development. It helps to open up possibilities for all aspects of the subject or need concerned, and suggests a variety of the methods available for delivery of teaching and learning. As with any checklist, it also helps to reduce the risks of overlooking some vital aspects of the development required.

Research Design

This study was an experimental research which was done in order to find out the effect of treatment on the dependent variables. In this research the relationship between the independent variables (LTM and Traditional) and dependant variables (Achievement and Retention Knowledge, comprehension, application and skills components of achievement and Retention) were found by conducting the test in the experimental group and the control group. Pre-test parallel group experimental design was found to be most appropriate for the study after review of literature on experimental designs.

In this study, in order to provide logical and data-based answers to the research questions, two homogenous groups of seventh standard students of two primary schools A and B in Mysore city, India, were selected. Two sections from these two schools were considered for the one experimental groups and one control group. 30 students were selected from each class and hence 60 students from school A and 60 students from school B formed the sample of the study. The participants were both male and female. Both schools were selected based on the following criteria.

- Being English medium
- Having Karnataka state syllabus
- Not having taught the selected four chapters of Nature and composition of matter, Water, Heat and Acid, Bases and Salts for the experiment.

The seventh standard science syllabus was studied and four chapters that were related to chemistry were selected. Since the students who were selected for the treatments were from different schools, the researcher had to make sure that they would have the same abilities before the treatment. In order to obtain parallel groups to the experimental and the control groups, the researcher administered the Test of Higher Mental Ability in Science for homogenizing the students.

According to Table 1 the P value of .000 is smaller than the cut-off point of .05, so our null hypothesis hypothesizing the lack of difference between the means of the two groups is rejected and it can be concluded that the students from the two schools had statistically significantly different means and were not homogenous.

The researcher had to search for a new school whose students' matched on Higher Mental Ability in science with one of two schools. Hence another school was selected and Test for Higher Mental Ability in science was administered to the students. The result of this test, in Table 2 showed that there is no significant difference based on the performances between the students of two schools.

Table 2 shows that the p-value of .867 was larger than .05 which meant that the null hypothesis assuming lack of difference between the means of the students from the two schools was confirmed. So it was concluded that the students in the two schools were homogenous with respect to Higher Mental Ability in science. The post-test was administered at the end of the experimental work to both the experimental and control groups to measure their terminal behaviour regarding the achievement in

	N	Mean	Std. Deviation	t-test for Equality of Means		
				Sig (2-tailed)	df	Sig
Group 1	60	11.7667	2.58366	.000	118	0.05
Group 2	60	8.4111	2.61755			

Table 1. Details regarding non-homogeneity of the groups initially selected

	N	Mean	Std. Deviation	t-test for Equality of Means		
				Sig (2-tailed)	df	Sig
Group 1	60	11.7667	2.58366	.867	118	0.05
Group 2	60	11.7111	1.79415			

Table 2. Details regarding homogeneity of the groups that were finally selected for the two experimental and control groups

chemistry. After a gap of one month the delayed post test for achievement in chemistry was administered to the experimental and the control groups to determine the retention level of the students.

Instrumentation

To verify the hypotheses of this study, the researcher needed to use a number of valid and reliable instruments. The followings are the research instruments that were used to collect the necessary data.

Test of Higher Mental Ability in Science (THMAS)

Sansanwal & Anuradha Joshi developed and standardized this test in 1989. It assesses the higher mental abilities like application, analysis, synthesis and evaluation in relation to science. The test contains 20 items and covers the above four abilities with 6, 6, 5 and 3 items each respectively. A few of the items are open-ended and some are multiple choice questions. Though the items make use of science content, they were designed in such a way that they assess the above said abilities and not knowledge or comprehension of science content. There was no time limit for the completion of the test. The level of reliability and validity of the test are explained below:

- *Reliability:* The test retest reliability was reported to range from 0.514 to 0.816 (n=110)
- *Validity:* The concurrent validity of the test with science achievement and total academic achievement were found to be 0.24 (n=104) 0.26 (n=102) respectively.

Achievement Test in Chemistry

The achievement test in chemistry was designed and developed by the present researcher. It contains 43 items including: 20 multiple choice items, 12 short-answer questions and 11 essay-type questions. The test covered four different content areas of knowledge, comprehension, application and skills. The test was constructed based on the content of the four chapters of the 7th Standard science book of Karnataka State Syllabus.

Construction: The items were constructed from the four chapters of chemistry which were taught using LTM method and traditional method. Since the selected chapters were not equal in size and volume, the researcher had to specify the weight of the marks allotted to each chapter according to their size and volume. Finally 30% of the mark weightage was given to chapter 'Nature and Composition of Matter', 19% weightage was given to "Water", 21% weightage was given to "Heat" and 30% weightage was given to "Acid, Bases and Salts". The test was designed based on the basis of Bloom's taxonomy of objectives. The weightages were given to different objectives and thus 31% that is 31 marks were allocated to Knowledge, 29% that is 29 marks for to Comprehension, 28% that is 28 marks for to application and 12% that is 12 marks were allocated to Skills. Based on these weightage tables the blue print of Achievement in Chemistry was prepared.

Item Analysis

In order to validate the newly developed test, the researcher needed to make sure that the items and the tests had the necessary qualities. In order to do that, at first the researcher conducted a tryout of the test to see whether the test possessed the necessary characteristics of a good test and whether its items had the required characteristics. The item characteristics tested were: item facility, item discrimination, choice distribution.

Item facility

After calculating the item facility of all the questions, the researcher selected the questions which were in the acceptable range. From among the total of 73 questions in the pretesting phase , 20 questions from multiple choice items and 14 questions from short answer questions and 13 questions from long answer questions and skills were in acceptable range for item facility and so they were included in the final instrument.

Item discrimination

By calculating the item discrimination of all the questions, the researcher selected the questions which possessed high discriminatory power. Among the total of 73 questions, 20 multiple choice items, 12 short answer items and 12 questions from long answer questions and skills were in acceptable range for item discrimination.

Choice distribution

From the total of 38 multiple choice items, 20 items were in the acceptable range for choice distribution and were good items but 18 items were not in acceptable range with

respect to choice distribution and had to be removed.

Investigation of Test Characteristics

Hence out of the 73 items of test in the pretesting phase 30 items were deleted. The final test was thus consisted of 43 items. After establishing the good quality of the items, the reliability and validity of the instruments were established.

Reliability

The reliability of the achievement test in chemistry was calculated using two methods.

(i) Test-retest, (ii) Cronbach's Alpha

Test-retest

To measure the reliability of the achievement test in chemistry, the researcher used test-re-test method. The details of the test-retest validity are given in Table 3.

As shown in Table 3, the coefficient of correlation was calculated for the test and re-test scores. The obtained coefficient of correlation was 0.763 and was found to be significant at 0.01 level as the P value of .000 was smaller than .01. The coefficient of stability was found to be 0.736 which is a significantly high index of reliability. Hence the test is found to have high reliability.

Cronbach's alpha test of reliability

The Cronbach's alpha correlation coefficient was found to be 0.763 which indicated a high index of reliability. Table 4 shows the Cronbach's alpha correlation coefficient.

Validity

The various types of validity established are as follows:

Face validity

In order to establish the validity of the tool the researcher established its face validity. The researcher and a few subject experts from the field of chemistry and language testing approved the newly developed test in terms of its face validity.

Content validity

In order to establish its content validity, the researcher sent the final draft of the test to 15 experts in the field of education. The experts unanimously approved its appropriateness for the intended purpose.

Criterion-related validity

To determine whether the newly developed test could really test the knowledge of chemistry of the students, it was compared with an already established test which had been administered to the students before. The results the students obtained from that test were compared with the results of this test. Table 5 shows that there was a moderate correlation between the two and this made the researcher sure that the newly developed test was a suitable test and could measure what it was intended to measure.

Sampling Procedure

The sample has been selected in two stages. In the first stage the schools were selected and in the second stage the classes were allotted to different groups.

Selection of schools

The sampling technique adopted for selecting the schools in this study was purposive sampling because the researcher selected the schools from the city of Mysore. This is because teaching chemistry in 21 sessions for each class would have been practically impossible in other cities of the state where the researcher had no contacts.

Selection of classes

Since in each school the number of seventh standard classes was more than two classes, the used the lottery method to select the classes for different experimental methods. In this method the names of seven standard classed in each school were written in small papers and among them one class for Laboratory Training Model of teaching and one class for Traditional method were selected.

	N	Pearson Correlation	Sig. (2-tailed)
Test 1-Test 2 (Test-retest)	91	.763	.000

Table 3. Table showing the details of the test-retest validity

	N	Mean	Std. Deviation	Pearson Correlation	Sig. (2-tailed)	Level of significance
Cronbach's alpha	91	52.3736	19.71781	.763	.000	0.05
		52.5549	20.97240			

Table 4. SPSS Output for Cronbach's alpha test of Reliability

N	Mean	Std. Deviation	Pearson Correlation
91	52.3736	19.71781	0.655
	80.4835	10.01040	

Table 5. Table showing the criterion related validity of chemistry achievement test

Investigation of the First Null Hypothesis

There is no significant difference in students taught by LTM and Traditional methods with respect to post scores in:

- Achievement in chemistry
- Knowledge-, comprehension-, application-, and skills-components of achievement
- Retention of achievement in chemistry
- Knowledge-, comprehension-, application-, and skills-components of achievement in retention

H01a: Overall achievement in chemistry

To verify H01a the researcher tabulated the raw data of the overall achievement test of chemistry students taught by LTM, and traditional methods and compared them. The comparison of the means of the two groups showed that they had different means. Figure 1 shows the difference graphically.

To determine whether the observed differences among the two means were significant, the raw scores of the two groups were subjected to the independent sample t-test to compare students taught by LTM, and traditional methods, post scores in overall achievement in chemistry. As Table 6 shows, the t-value of 21.847 was found to be statistically significant as the p-value of .000 was smaller than the cut-off .05. This showed that there was significant difference between students taught by LTM, and traditional methods with respect to post scores in overall achievement in chemistry. This rejected H01a.

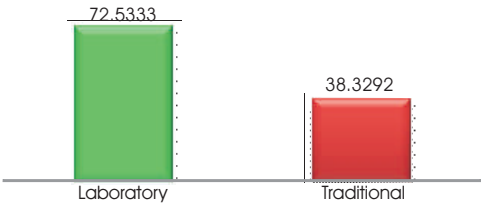

Figure 1. LTM, and Traditional students; overall scores in achievement in chemistry

Treatment	N	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Achievement							
Laboratory	60	72.5333	8.86820	1.14488	21.847	118	.000
Traditional	60	38.3292	8.27218	1.06793			

Table 6. Table showing T-test results for effect of gender on overall achievement in chemistry

H01b: Components of knowledge, comprehension-, application-, and skills-achievement

To determine whether the observed differences among the two means were significant, the raw scores of the two groups were subjected to the independent sample t-test to compare students taught by LTM, and traditional methods, post scores in knowledge-, comprehension-, application-, and skills-components of achievement test of chemistry. As Table 7 shows, Components of knowledge the t-value of -4.272, Components of comprehension the t-value of 12.205, Components of Application the t-value of 22.402and Components of Skills the t-value of 21.590 were found to be statistically significant as the p-value of .000 were smaller than the cut-off .05. This showed that there were significant difference between students taught by LTM, and traditional methods with respect to post scores in knowledge, comprehension-, application-, and skills-components of achievement test in chemistry. This rejected H01b. Figure 2 shows the difference graphically.

H01c: Retention of achievement in chemistry

To verify H01c the researcher tabulated the raw data of the retention of achievement in chemistry students taught by LTM, and traditional methods and compared them. The comparison of the means of the two groups showed that they had different means. Figure 3 shows the difference graphically.

To determine whether the observed differences among

	Treatment	N	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Knowledege	Laboratory	60	1.1436	.20461	.02641	-4.272	118	.000
	Traditional	60	1.2974	.18960	.02448			
Comprehension	Laboratory	60	1.6606	.37453	.04835	12.205	118	.000
	Traditional	60	.8486	.35390	.04569			
Application	Laboratory	60	1.5194	.31940	.04123	22.402	118	.000
	Traditional	60	.4396	.19338	.02497			
Skills	Laboratory	60	4.9000	.55337	.07144	21.590	118	.000
	Traditional	60	1.1889	1.21101	.15634			

Table 7. T-test results for effect Components of Achievement in chemistry

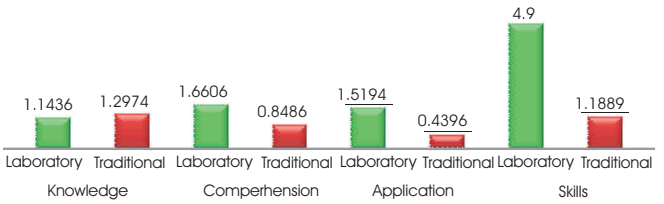

Figure 2. LTM, and Traditional students; overall scores in Components of Achievement in chemistry

Figure 3. LTM, and Traditional students; Retention of achievement in chemistry

the two means were significant, the raw scores of the two groups were subjected to the independent sample t-test to compare students taught by LTM, and traditional methods, post scores in retention of achievement in chemistry. As Table 8 shows, the t-value of 18.019 was found to be statistically significant as the p value of .000 was smaller than the cut-off .05. This showed that there was significant difference between students taught by LTM, and traditional methods with respect to post scores in retention of achievement in chemistry. This rejected H01c.

H01d: Components of knowledge, comprehension-, application-, and skills -Retention of achievement in chemistry

To verify H01d the researcher tabulated the raw data of the Components of knowledge, comprehension-, application-, and skills -Retention of achievement in chemistry students taught by LTM and traditional methods and compared them. The comparison of the means of the two groups showed that they had different means. Figure 4 shows the difference graphically.

To determine whether the observed differences among the two means were significant, the raw scores of the two groups were subjected to the independent sample t-test to compare students taught by LTM, and traditional methods, post scores in retention of achievement in chemistry. As Table 9 shows, Components of knowledge the t-value of -4.272 Components of comprehension t-value of 11.190, Components of Application the t-value of 18.337 and Components of Skills the t-value of 21.590 were found to be statistically significant as the p value of .000 was smaller than the cut-off .05. This showed that there were significant differences between students taught by LTM, and traditional methods with respect to post scores in the Components of knowledge, comprehension-, application-, and skills -retention of achievement - in chemistry. This rejected H01d.

Investigation of The Second Null Hypothesis

There is no significant difference between male and female students with respect to post scores in:

- Achievement in chemistry
- Knowledge-, comprehension-, application-, and skills-components of achievement
- Retention of achievement in chemistry
- Knowledge-, comprehension-, application-, and skills-

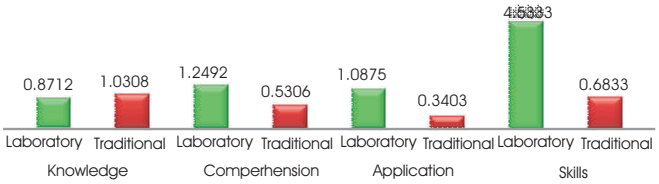

Figure 4. LTM, and Traditional students; overall scores in Components of Retention of achievement in chemistry

Treatment	N	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Retention Laboratory	60	56.2958	8.06981	1.04181	18.019	118	.000
Traditional	60	27.2583	9.52350	1.22948			

Table 8. T-test results for effect of gender on Retention of achievement in chemistry

	Treatment	N	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Knowledege	Laboratory	60	.8712	.24864	.03210	-4.272	118	.000
	Traditional	60	1.0308	.26917	.03475			
Comprehension	Laboratory	60	1.2492	.35293	.04556	11.190	118	.000
	Traditional	60	.5306	.35057	.04526			
Application	Laboratory	60	1.0875	.24292	.03136	18.337	118	.000
	Traditional	60	.3403	.20154	.02602			
Skills	Laboratory	60	4.5333	.91894	.11863	21.590	118	.000
	Traditional	60	.6833	1.03138	.13315			

Table 9. Table showing T-test results for effect Components of Retention of achievement in chemistry

components of achievement in retention

H02a: Overall achievement in chemistry

To verify H02a the researcher tabulated the raw data of the overall achievement test of chemistry of male and female students and compared them. The comparison of the means of the two groups showed that they had different means. Figure 5 shows the difference graphically.

To determine whether the observed differences among the two means were significant, the raw scores of the two groups were subjected to the independent sample t-test to compare the male and female students' post scores in overall achievement in chemistry. As Table 10 shows, the t-value of -.096 was found to be statistically insignificant as the p value of .924 was larger than the cut-off .05. This showed that there was no significant difference between male and female students with respect to post scores in overall achievement in chemistry. This confirmed H02a.

H02b: Components of achievement

To verify H02b, the researcher tabulated the raw data of the knowledge-, comprehension-, application-, and skills-components of achievement test of chemistry obtained from two groups of students taught by LTM and traditional methods. Figure 6 shows, the means of the male and female students in each component were very close to each other.

Figure 5. Male And Female Students; Overall Scores In Achievement In Chemistry

Gender	N	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Achievement Male	61	63.3320	26.94793	3.45033	-.096	118	.924
Female	59	63.8051	27.17441	3.53781			

Table 10. T-test results for effect of gender on overall achievement in chemistry

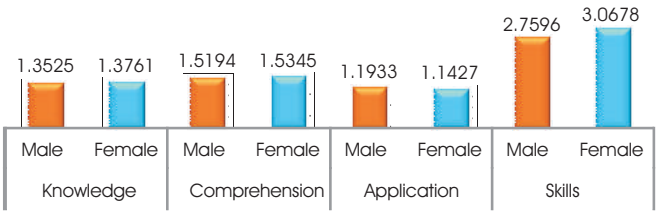

Figure 6. Means Of The Male And Female Students; (knowledge, Comprehension, Application And Skills-components Of Chemistry Achievement Test)

To decide if the observed differences between the means of the male and female students in each component were statistically significant or not, their means in each component were compared using t-test.

The results of the four independent sample t-tests applied for the four components as Table 11 shows that in none of the four cases the differences between the means of the male and female students were statistically significant. This confirmed H02b which had hypothesized no difference between male and female students with respect to post scores in knowledge-, comprehension-, application-, and skills- components of achievement in chemistry.

H02c: Retention in chemistry

To verify H02c the researcher tabulated the raw data of the overall retention test of chemistry of male and female students and compared them. The comparison of the means of the two groups showed that they had different means. Figure 7 shows the difference graphically.

To determine whether the observed differences between the two means were significant, the raw scores of the two groups were subjected to the independent sample t-test to compare the male and female students' post scores in overall retention in chemistry. As Table 12 shows, the t-value of -.847 was found to be statistically insignificant as the p value of .398 was larger than the cut-off .05. This showed

	Gender	N	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Knowledege	Male	61	1.3525	.18661	.02389	-.785	118	.434
	Female	59	1.3761	.13960	.01817			
Comprehension	Male	61	1.5194	.79375	.10163	-.106	118	.916
	Female	59	1.5345	.75731	.09859			
Application	Male	61	1.1933	.77336	.09902	.361	118	.718
	Female	59	1.1427	.76161	.09915			
Skills	Male	61	2.7596	1.88403	.24122	-.833	118	.406
	Female	59	3.0678	2.16271	.28156			

Table 11. T-test Results For Effect Of Gender On Component-level Achievement In Chemistry

Figure 7. Male and female student's scores in retention in chemistry

Gender	N	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Retention Male	61	46.7402	23.38535	2.99419	-.847	118	.398
Female	59	50.4449	24.50220	3.18992			

Table 12. T-test Results For Effect Of Gender On Retention

that there was no significant difference between male and female students with respect to post scores in retention. This confirmed H02c.

H02d: Components of Retention

To verify H02d, the researcher tabulated the raw data of the knowledge-, comprehension-, application-, and skills-components of Retention test of chemistry obtained from two groups of students taught by LTM and Traditional methods. As Figure 8 shows, the means of the male and female students in each component were very close to each other.

To decide if the observed differences between the means of the male and female students in each component were statistically significant or not, their means in each component were compared using t-test.

The results of the four independent sample t-tests applied for the four components as shown in Table 13 showed that in none of the four cases the differences between the means of the male and female students were statistically significant. This confirmed H02d which had hypothesized no difference between male and female students with respect to post scores in knowledge-, comprehension-, application-, and skills- components of retention in chemistry.

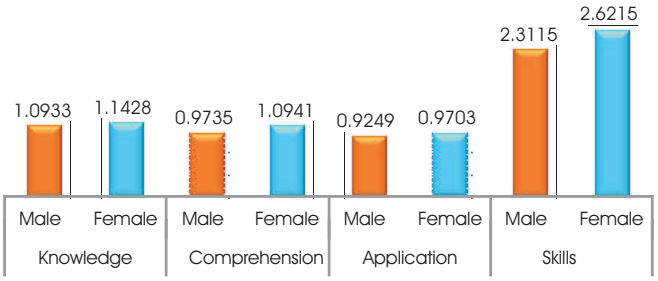

Figure 8. Means of the Male and female students; (Knowledge, Comprehension, Application and Skills-Components of chemistry retention test)

	Gender	N	Mean	Std. Deviation	Std. Error Mean	t	df	Sig.(2-tailed)
Knowledege	Male	61	1.0933	.27028	.03461	-1.031	118	.434
	Female	59	1.1428	.25443	.03312			
Comprehension	Male	61	.9735	.58468	.07486	-1.092	118	.916
	Female	59	1.0941	.62511	.08138			
Application	Male	61	.9249	.65062	.08330	.375	118	.718
	Female	59	.9703	.67860	.08835			
Skills	Male	61	2.3115	2.18485	.27974	-.792	118	.406
	Female	59	2.6215	2.09858	.27321			

Table 13. T-test Results For Effect Of Gender On Component-level Retention In Chemistry

Result and Discussion

Teaching chemistry through the LTM method is effective and should receive its due attention. The reasons for the observed superiority of the LTM on the traditional one are not very difficult to understand. By way of exemplification, if a student only listens to his teacher's description of, say, the word snow, his understanding of the described word is surely much weaker and more subject to forgetting than when the verbal description is reinforced by giving the learner the chance of touching and feeling the snow on a snowy day. In the latter case, the learner's mental connection with the newly learned word is through more senses than just hearing. He sees touches as well as hears about the concept of snow and this deepens his learning and minimizes the chance of forgetting. LTM may not be able to give the students the chance of feeling the coldness of snow and touching the snowflakes, but can bring the learners as close to the reality of this experience as Laboratory class permits. Once the learners face to some real situations and doing some experiments in first hand, the understanding of the topic would be easier for them. In this study, the researcher provided a situation which gave the learners the chance of learning the chemistry concepts through more senses than just hearing and provided them with the opportunity to observe many relationships that could never be explained verbally in the traditional method. That is why LTM proved more effective than the traditional method of teaching chemistry which relies heavily on the auditory senses of the learners. The ranking of the LTM and traditional methods from highest to lowest respectively is not different for girls and boys. Therefore, both male and female student equally benefit from LTM and are negatively affected by the traditional method. As far as the overall achievement in chemistry is concerned, the LTM method of teaching chemistry was found to be much more effective than the Traditional method. When it came to the achievement in the knowledge-, comprehension-, application-, and skills components of chemistry, the LTM method was more effective than the Traditional method in the case of all the four components. As for the effects of the two methods of

teaching chemistry on the retention of learned materials, the findings of the study suggested that students taught through LTM method of teaching chemistry retained what they had learned better than the students who were taught through the Traditional methods. This was true both for the overall achievement and the individual components of the achievement in chemistry. The same results were found when the male and female students' scores were compared in each of the four components of the achievement in chemistry. There was no significant interaction between the effect of treatment and gender of students taught by LTM and Traditional method in respect to their overall achievement in chemistry, nor was there an interaction between the effects of gender and treatment in relation to their post scores in the knowledge-, comprehension-, and application components of achievement in chemistry. However, female students taught by LTM performed better than the male students taught by the same method in the skills-component of chemistry achievement test.

Clearly opine that LTM "refers to a broad field encompassing computers, communications equipment and the services associated with them." LTM is not just considered as applications and systems but also as skill for life. In this sense it is regarded in line with literacy and numeracy as a fundamental skill which every individual needs so as to live "confidently, effectively and independently in a modern society.

As teachers develop greater confidence and skill in the use of educational technology, there will be more attempts to integrate LTM into the teaching and learning processes.

While the Laboratory Training Model of teaching chemistry proved to be more effective than the traditional method in almost all components of the achievement in chemistry, its inferiority to the traditional method in the knowledge –component indicated that the Laboratory Training Model of teaching is not as suitable for teaching non-experimental and lower-level components as it is for the teaching of higher-levels of knowledge and experimental concepts.

If Laboratory Training Model of teaching chemistry is to be incorporated in the curriculum, one important part of the curriculum that should experience this change is the materials used for teaching chemistry. If the books are designed in such a way that they can be taught through the traditional lecturing of the teachers and the passive listening of the students, cannot the teachers and the students be expected to teach and learn those books through methods other than the traditional method. Chemistry teaching materials must no longer be limited to a few volumes of chemistry books that can be taught through teachers' lecturing. Laboratory equipment must no longer be viewed as a luxury that can occasionally be used in science classes and they must become part of every chemistry course. Through development of teaching materials by incorporating (LTM) for teaching chemistry we could expect teachers, schools, students and parents to take use LTM in the teaching of chemistry particulars, and all the other branches of science in general.

The researcher would like to use the capacity of this paper to refer to the implications of this study for curriculum development, material development, teacher education, school equipment, and testing systems.

Conclusion

The researcher would like to conclude that the use of laboratory equipments and environment both make the learners more interested in the subject under discussion and help them understand those same concepts by making them more tangible and less abstract. Not only was the LTM method more effective in the overall achievement and retention of chemistry but it was also more effective than the traditional method in the knowledge-, comprehension-, application-, and skills components of chemistry. The noticeable observation was that in the skills –component the difference between the effect of LTM and the traditional methods was much stronger than their difference in the other components. The conclusion that can be drawn from this observation is that the traditional methods of teaching chemistry or any other subject for that matter can be somehow effective at the less demanding levels of learning such as knowledge or comprehension. But for more advanced levels of learning like application and skills-levels, the traditional method proves completely inefficient. Gender had no effect on the overall

achievement and retention in chemistry as the performance of the male and female students in the overall achievement and retention test of chemistry did not show any statistically significant difference.

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