



EFFECTIVENESS OF USING MATHEMATICS LABORATORY IN TEACHING CHEMISTRY ON ACHIEVEMENT OF SECONDARY SCHOOL STUDENTS

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ABSTRACT

The present study investigated the Effectiveness of Using Mathematics Laboratory in Teaching Chemistry on Achievement of Secondary School Students. Using Laboratory is a procedure for stimulating the activities of the Students and to encourage them to make discoveries and it is also based on the principle of learning by doing. Researcher adopted 'Pre-test'-'Post-test' Experimental and control group design under True Experimental Research. The sample consisted of 80 students of standard X from National Public School, Shivamogga, Karnataka. 40 students were assigned to the experimental group and 40 students in the control group equate through academic performance of previous year. The experimental group was taught using Mathematics Laboratory and the Control Group was taught through the Conventional method. The data were analyzed using t-test. From the findings, it was observed that the use of mathematics laboratory in teaching chemistry Enhanced Achievement in Chemistry. This method is suitable for teaching chemistry to the lower classes and higher classes as at this stage teaching is done with the help of concrete things and examples.

KEYWORDS : Effectiveness, Chemistry, Mathematics Laboratory and Achievement

INTRODUCTION:

Chemistry is a core science. At some point in any other science we need to understand at least some of the concepts we are being taught right now. We can't do medicine at any level (from Nurse to Physician Assistant to Physician) without knowing chemistry. Biology, physics, geology metallurgy, all assume we have a basic knowledge of atoms, molecules, electrons, measurement, significant figures, etc. That is why it is taught at the High School level--it is basic to anything else we plan to do. In other words, in high school chemistry, we should realize that Chemistry's is not about memorization. It's about understanding the universe and life.

Mastering Chemistry requires some critical mass of facts memorized, and understanding the concepts (Structure of Matter, Chemical Structure/Valence, Periodic Table, Mechanisms of reactions, Thermodynamics). When we get it, things fall into places and Chemistry is easy.

The problem of High-School Chemistry is that in a usual school they do not spend enough time on it, so the facts look like a wild forest unordered by the concepts, and the concepts dangle in the midair unsupported by facts. A good tutor and a bit of your own motivation make wonders. Chemistry is not only fascinating to study and practice but important as well. It is a window into the foundations of biology and physics and can provide insights both practical and interesting.

There are so many practical benefits to the study of chemistry it is hard to provide a broad overview in such a short space. But, if we think about it nearly every part of our life is related in some way to chemistry. What we wear, eat, drive, where we live, the air we breathe, what medicines we take. All of these areas of our life where we have to make decisions would be enhanced by some working knowledge of chemistry. So, take a look around and see how our life is touched by chemistry and begin to study these areas on a molecular level.

Chemists use math for a variety of tasks. They balance the equation of a chemical reaction, use mathematical calculations that are absolutely necessary to explore important concepts in chemistry, and utilize dimensional analysis to find any range of information about reactions from finding the mass of chemicals reacted to the concentration of a chemical in a solution. Math is also used to calculate energy in reactions, compression of a gas, grams needed to add to a solution to reach desired concentration, and quantities of reactants needed to reach a desired product.

Significance of the Study:

Mathematics is used widely in chemistry as well as all other sciences. Mathematical calculations are absolutely necessary to explore important concepts in chemistry. Without some basic mathematics skills, these calculations, and therefore chemistry itself, will be extremely difficult. However, with a basic knowledge of some of the

mathematics that will be used in your chemistry course, you will be well prepared to deal with the concepts and theories of chemistry.

Typically, mathematics is regarded as a useful tool by chemists, and all undergraduate chemists will need to attend some sort of mathematics course in order to access and make the most of their science. There are various levels of mathematics used in chemistry degrees, ranging from combinatorial and proportional reasoning to heavy-weight differential equations and Fourier analysis. However, study of any of the underlying mathematics out of context tends to reduce mathematical activity to a series of clean, dry routines and procedures. Many students then struggle with applying the quantitative knowledge in the complicated chemical contexts they encounter.

Mathematics is an essential skill for chemistry students to master; the number of chemistry departments either requiring or recommending study of A-level mathematics is but one indicator.

Mathematics is used widely in chemistry as well as all other sciences. Mathematical calculations are absolutely necessary to explore important concepts in chemistry. Without some basic mathematics skills, these calculations, and therefore chemistry itself, will be extremely difficult. However, with a basic knowledge of some of the mathematics that will be used in your chemistry course, we will be well prepared to deal with the concepts and theories of chemistry.

The knowledge of mathematics is much required to learn chemistry. There are very few studies which has specified the importance of math's in teaching chemistry.

Considering the acquisition of problem solving skills in chemistry, it seems reasonable to introduce tasks, which aim at problem solving by using mathematical models. A conscious handling of mathematical models demands the transfer and usage of mathematical knowledge in new and significant situations and thus can support the comprehension of the terms that were modelled and foster problem solving skills.

The following quotation points out the definition of mathematical modelling, which is used in didactics of mathematics:

Many students leave high school chemistry courses with profound misunderstandings about the nature of matter, chemical processes, and chemical systems.

Most of the studies emphasized on the learning of chemistry by using mathematics knowledge. No research has been done on use of mathematics lab to learn chemistry. Few studies were done on showing inter relationship between the two subjects.

Review of related literature of this study enabled the researcher to know the details of studies conducted in the area. But the literature on

the relationship between Teaching Chemistry and Mathematics lab is not there. Even though number of studies undertaken are many, the review develops an understanding about the status of the research in the problem area ensured. This enabled the researcher to finalize the need for present study. In view of inconclusive trend of findings of research studies, it helped the investigator to frame objectives, list out variables, formulate hypotheses, finalize tools and conclude the relevant statistical techniques to be used for making the study more fruitful, meaningful and interesting.

Keeping in view of the above said factors, this study will be focused on the following points.

- All students should be expected to attain a high level of scientific competency.
- All students should have access to supportive, challenging programs in science, mathematics, and technology, and all students should acquire literacy in these subjects by direct experience with the methods and processes of inquiry.
- Students should thoroughly learn a limited number of science and mathematics concepts rather than lightly touch on many.
- Curricula should stress understanding, reasoning, and problem-solving rather than memorization of facts, terminology, and algorithms.
- Teachers should engage students in meaningful activities that regularly and effectively employ calculators, computers, and other tools in the course of instruction.

Statement of The Problem:

" Effectiveness of Using Mathematics Laboratory in Teaching Chemistry on Achievement of Secondary School Students "

VARIABLES OF THE STUDY

The study involves the following variables.

INDEPENDENT VARIABLES:

Group	Pre-test	Independent Variable (treatment)	Post-test	Delayed Post-test
Experimental Group	• Achievement in Chemistry	Teaching Chemistry Using Mathematics Lab	• Achievement in Chemistry	• Achievement in Chemistry
Control Group	• Achievement in Chemistry	Traditional Teaching	• Achievement in Chemistry	--

Table 2 : Phases Of The Study

Stage	Control Group	Experimental Group
I	Measurement of intelligence of pupils.	
II	Pre-testing • Measurement of achievement in Chemistry.	• Measurement of achievement in Chemistry.
III	Treatment Teaching chemistry through conventional method.	Teaching Chemistry Using Mathematics Lab.
IV	Post-testing • Measurement of achievement in Chemistry.	• Measurement of achievement in Chemistry.
V	Delayed post test _____	• Measurement of achievement in Chemistry.

3.6.2 OPERATIONAL DEFINITIONS

- **Effectiveness:** The capability of producing a desired result. Here the term effectiveness refers to the teaching of chemistry by using practical knowledge gained in maths lab, the effective teaching refers to clarify the mathematical concepts not by using traditional way of teaching but applying the knowledge gained in mathematics lab.
- **Teaching Chemistry:** Teaching is The act of imparting knowledge In accordance with this research, Teaching Chemistry is defined as, teaching Chemistry by using mathematics lab of the selected topics from class 8th, 9th and 10th prescribed by Government of Karnataka.
- **Secondary School Students:** With reference to the present study, "Secondary School Students" are those "Students studying in Class IX and X from schools of shivamogga city.

Mathematics Laboratory: A Mathematics Laboratory or Math lab is a classroom or designated space to teach math lessons in an interactive

- Teaching Chemistry Using Mathematics Lab (Experimental group)
- Traditional Teaching (Control group)

DEPENDENT VARIABLE:

- Achievement in Chemistry (Both pre and post test)

OBJECTIVE OF THE STUDY

To find out the effectiveness of Teaching Chemistry using Mathematics Lab in pre and post test scores of students with regard to Learning Chemistry

HYPOTHESIS OF THE STUDY

To make the research meaningful the researcher has formulated five hypothesis.

1. There is no significant difference between pre-test & post-test scores of achievement in chemistry of control group.
2. There is no significant difference between pre-test & post-test scores of achievement in chemistry of experimental group.
3. There is no significant difference between pre-test scores of achievement in chemistry of control and experimental group.
4. There is no significant difference between post-test scores of achievement in chemistry of control group and experimental group.
5. There is no significant difference between post-test & delayed post-test scores of achievement in chemistry of the experimental group

METHODOLOGY

Experimental Design:

The present study is an experimental study as it aimed to study the Effectiveness of Teaching Chemistry Using Mathematics Lab for IX standard students. A two group randomized subjects (experimental and control), pre-test, post-test design is used in the present study.

and engaging way. According to CBSE Guidelines for Mathematics laboratory in Schools, it is a room wherein we find collection of different kinds of materials and teaching/learning aids, needed to help the students understand the concepts through relevant, meaningful and concrete activities. These activities may be carried out by the teacher or the students to explore the world of mathematics, to learn, to discover and to develop an interest in the subject.

Achievement test: It is the performance test to which a student, teacher or institution has achieved their short or long-term educational goals

Statistical Technique Used:

The data obtained on conducting the pre-tests and post-tests were tabulated and analysed using appropriate statistical techniques. Descriptive and inferential statistical techniques such Mean, Standard Deviation and Test of Significance of Difference between the Means of Two Independent Groups (t-test) were used to analyze the research data.

Development of the Teaching Chemistry through Mathematics Lab Package.

Development of the Teaching Chemistry through Mathematics Lab Package consists of following factors,

- i. Content and activities are flexible for teachers to suit the situation.
- ii. Keeps the interest and motivation among the students throughout the programme.
- iii. Provision to continuous and Comprehensive evaluation
- iv. Activities can be performed by the Students on their own with the instructions.
- v. Materials used are cost effective and available readily within the local environment
- vi. Active use of process skills of observation, classification and inference was facilitated.
- vii. Provisions for self learning and self experiments.

viii. Can be readily used by the teachers readily.

Procedure to Develop Teaching Chemistry through Mathematics Lab Package

The steps followed for Construction and Standardization of Teaching Chemistry through Mathematics Lab Package are as follows.

1. Planning
2. Preparation of Lesson Plan
3. Pilot Study
4. Establishing Validity and reliability.

1. Planning

The content analysis of the texts of Science and Mathematics of secondary classes was done to check for the adequacy and relevance for developing Teaching Chemistry through Mathematics Lab Package. Written the instructional objectives and the contents, the materials were analysed and teaching techniques are chosen. This package is used for class 10 students. About twenty two Concepts of interrelated Mathematics and Chemistry were chosen. Before writing lesson plan possibility of Connecting Mathematics Lab with Chemistry was checked by visiting Mathematics lab in Secondary Schools. Opinions and guidelines from Mathematics teachers using mathematics lab was taken and also possibility of interdisciplinary approach between mathematics Lab and other subjects were discussed. Written the instructional objectives and the contents, the materials were analysed and the interrelated Chemistry and Mathematics Contents were Chosen. Each concept was taught in classroom and related activity was done in Mathematics lab, number of concepts.

2. Preparation of Lesson Plan

About 22 basic teaching Concepts related to Secondary School are considered for developing the package. These concepts are from class 8,9 and 10 of Science and Mathematics textbooks. The concepts are written on the basis of constructivism theory and lesson plans are executed based on activity method which include laboratory method. care is taken so that most of the concepts are learner centred. The lessons are planned in such a way that teacher only acts as a Facilitator while learning is done by students themselves by exploring the concepts. The draft of the package was prepared. Activities and questions were to be posed and feedback material was designed at the end of the each concept. Lesson plans were designed based on contents for particular period of teaching. Materials required for these activities also were listed out, submitted to the respective subject teachers and eminent experts from the field of education for scrutiny. It was based on their suggestions and the content was modified aptly. Students are free to express their learning. To make learning more interesting and effective they are supported with teaching learning materials which include Audios, Videos, Mathematics Lab equipments, Charts, Flash cards. The lessons plans were send to Eight Subject teachers (Mathematics and Chemistry) who are teaching in secondary schools, 4 Research experts, 4 Subject experts (lecturers of Chemistry and Mathematics)

3. Pilot Study

This phase included the development of the Programme. The Package validated on comprehensibility of the content and activities, difficulty level, time factor, suitability for the given age group and ability level, extent of facilitation for achieving specified instructional objectives. The problems faced by small group of sample were observed by the investigator holding had discussion with them, subsequently and on the basis of the feedback, the Package was finalized with suitable modifications.

Preliminary administration was made on small groups of 35 students of Mary Immaculate girls High School for about 3 months, which were not included in the sample. The problems faced by small group of sample were observed by the investigator, holding discussion with them subsequently and on the basis of the feedback, the Package was refined with suitable modifications. During the process opinions and observations of subject teachers and students were collected and accordingly required modification was done by considering their suggestion. Little modifications of lesson Plan, Improvisation of Teaching learning material was done to suit the Contents for class 10. Based on the experience and discussions with the subject experts, some modifications were made in the package to meet the criteria and package finalized for its execution. The Package implemented over a span of 3 months in about 60 periods of 40 minutes each from Monday to Friday of the week.

4. Establishing Validity and reliability

Eminent experts' opinions were taken on Relevance of Content to Secondary School Students, Clarity of content without Ambiguity, Interdisciplinary approach between Mathematics and Chemistry is properly established. Based on their suggestions, suitable refinement was made in the package. The package was validated by the experts by evaluating the questionnaire. The evaluation questionnaire assessed the suitability of Format, content, organization, and language structure of the Teaching Chemistry through Mathematics Lab Package and suitability of techniques for enhancing teaching and learning process by using package.

Tools used for the study

In the present study, valid, reliable and comprehensive achievement test was constructed to measure the achievement of students in Chemistry and Mathematics. The objective type of questions was framed from the selected topics of Secondary classes.

The Achievement test contained 102 items. With the views of experts and subject teachers, some were deleted and some were modified. Finally 85 items were retained for pilot study. While constructing the tests the following aspects were considered.

1. The test should adequately cover all the contents selected.
2. The test should be objective type.
3. Language of the items and instruction to respond to the items should be clear and appropriate to the level of students.
4. Items should be specific and unambiguous.

Materials: 22 lesson plans related to Teaching Chemistry through Mathematics Lab.

Plan: The lesson were taught to students by using Constructivism based SE method in classrooms by using mathematics lab equipments. The Types of the items are classified as follows,

Sl no	Objectives	Type of questions	% of objectives
1	Knowledge	Objective	20%
2	Understanding	Objective	20%
3	Application	Objective	30%
4	Skill	Subjective	30%

Analysis and Interpretation of the data

To fill in the research finding researcher has formulated five hypothesis

Hypothesis 1: There is no significant difference between pre-test scores of achievement in chemistry of control and experimental group.

Table 1: Mean, SD and t-value obtained between pre-test scores of achievement in chemistry of control and experimental group.

Test	Group	N	Mean	Standard Deviation	't' value	Significance (@0.05)
Pre test	Control Group	40	45.67	3.36	0.86	Not Significant
	Experimental Group	40	46.57	5.67		

The above table reveals that the obtained 't' value 0.86 is less than the theoretical table value 1.96 at 0.05 level of significance. Hence the null hypothesis is accepted i.e. "There is a significant difference between pre-test scores of achievement in chemistry of control and experimental group". Thus it can be concluded that the Mean test scores of Control Group and Experimental Group in Pre Test are similar.

Hypothesis 2: There is no significant difference between pre-test & post-test scores of achievement in chemistry of experimental group.

Table 2.: Mean, SD and t-value obtained between pre-test & post-test scores of achievement in chemistry of Experimental group.

Group	Test	N	Mean	Standard Deviation	't' value	Significance (@0.05)
Experimental Group	Pre test	40	46.57	5.67	26.48	Significant
	Post test	40	79.17	5.32		

The above table reveals that the obtained 't' value 26.48 is more than the theoretical table value 1.96 at 0.05 level of significance. Hence the null hypothesis is rejected i.e. "There is no significant difference between pre-test & post-test scores of achievement in chemistry of Experimental group." and alternative Hypothesis is formulated i.e.

“There is a significant difference between pre-test & post-test scores of achievement in chemistry of Experimental group.” as the mean test Scores of Pre and Post test are Significant and found to be different.

From the mean values it is evident that, effectiveness of post-test values (Mean=79.17) is higher than pre-test (Mean=46.57) on the achievement of secondary school students. This can be observed from table 2.

Hypothesis 3: There is no significant difference between pre-test & post-test scores of achievement in chemistry of control group.

Table 3 : Mean, SD and t-value obtained between pre-test & post-test scores of achievement in chemistry of control group.

Group	Test	N	Mean	Standard Deviation	't' value	Significance (@0.05)
Control Group	Pre test	40	45.67	3.3	0.86	Not Significant
	Post test	40	46.97	3.4		

The above table reveals that the obtained 't' value 0.86 is less than the theoretical table value 1.96 at 0.05 level of significance. Hence the null hypothesis is accepted i.e. “There is no significant difference between pre-test & post-test scores of achievement in chemistry of control group”. Hence it can be concluded that the Mean test scores are similar and there is no difference between the scores of Pre and Post test in Control group.

Hypothesis 4: There is no significant difference between post-test scores of achievement in chemistry of control group and experimental group.

Table 4 : Mean, SD and t-value obtained between post-test scores of achievement in chemistry of control group and experimental group.

Test	Group	N	Mean	Standard Deviation	't' value	Significance (@0.05)
Post test	Control Group	40	46.97	3.4	32.02	Significant
	Experimental Group	40	79.17	5.3		

The above table reveals that the obtained 't' value 32.02 is more than the theoretical table value 1.96 at 0.05 level of significance. Hence the null hypothesis is rejected, i.e. “There is no significant difference between post-test scores of achievement in chemistry of control group and experimental group”. So the null hypothesis was rejected and alternative hypothesis “There is a significant difference between post-test scores of achievement in chemistry of control group and experimental group” was formulated. It means that, there exists a significant difference in the post-test mean values of control group. From the mean values it is evident that, effectiveness of post-test values conventional method of teaching (Control Group, M=46.97) are lower than the Experimental method teaching values (Experimental group, Mean=29.90) on the achievement in Chemistry. This can be observed from table 4.

Hypothesis 5: There is no significant difference between post-test & delayed post-test scores of achievement in chemistry of the experimental group.

Table 4 : Mean, SD and t-value obtained between post-test & delayed post-test scores of achievement in chemistry of the experimental group.

Group	Test	N	Mean	Standard Deviation	't' value	Significance (@0.05)
Experimental Group	post-test	40	79.17	5.32	0.12	Not Significant
	delayed post-test	40	79.32	5.2		

The above table reveals that the obtained 't' value 0.12 is less than the theoretical table value 1.96 at 0.05 level of significance. Hence the null hypothesis is accepted i.e. “There is no significant difference between post-test & delayed post-test scores of achievement in chemistry of the experimental group”. The mean test Scores of Experimental Post test and Delayed Post test are Not Significant and found to be same.

RESULTS OF THE STUDY

1. there is no significant difference between pre-test scores of

achievement in chemistry of control and experimental group as the Mean test scores of Control Group and Experimental Group in Pre Test are similar.

- There is a significant difference between pre-test & post-test scores of achievement in chemistry of Experimental group, as the mean test Scores of Pre and Post test are Significant and found to be different.
- There is no difference between the Pre and Post test scores of achievement in chemistry of Control group as the Mean test scores are similar.
- There is a significant difference between post-test scores of achievement in chemistry of control group and experimental group, as there exists a significant difference in the post-test mean values of control group. From the mean values it is evident that, effectiveness of post-test values conventional method of teaching (Control Group, M=46.97) are lower than the Experimental method teaching values (Experimental group, Mean=29.90) on the achievement in Chemistry.
- There is no significant difference between post-test & delayed post-test scores of achievement in chemistry of the experimental group, as the mean test Scores of Experimental Post test and Delayed Post test are Not Significant and found to be same.

Educational implications:

- Permitting the students to learn abstract concepts through concrete experiences and thus increasing the understanding of those ideas.
- Making students to see the origin of mathematical ideas and participating in "mathematics in the making and apply the same to chemistry.
- Arousing interest and motivating learning, cultivating favorable attitudes towards mathematics and Chemistry.
- Context and opportunity to discover through doing, through activities students learn to do.
- Offers more scope for individual participation
- Encourages students to become independent and allows them to learn them at their own pace.
- It widens the experimental base and lays groundwork for chemistry.
- Maths lab help to develop metacognitive abilities.

Delimitations of the study

The following are the delimitations of the study

- The present study is confined to only 10th standard School Students.
- It is restricted to only for 80 students.
- The present research was delimited to Chemistry subject only.
- The present research was delimited to Shimoga city only.

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