



ORIGINAL ARTICLE

**An Investigation of Major Factors that Hinder Chemistry Laboratory in Asella
College of Teacher Education, Oromia Region, Ethiopia**

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ABSTRACT

The major concern of this study was to examine an investigation of the main factors that hinder chemistry laboratory in Asella College of Teacher Education. The sample consisted of 60 students, 6 instructors and lab-technician and 5 college managements from the study area. Data collection instruments were questionnaires, interview and observation. Data obtained from questionnaires were analysed quantitatively using statistical tools like frequency and percentage. The data obtained from interview was analyzed qualitatively and data obtained from observation was analyzed quantitatively and qualitatively. The results from the study showed that, factors that affect chemistry laboratory in Asella College of Teacher Education were unavailability of chemicals, equipment's and apparatus, shortage of instructional materials, lack of external and internal facilities, inappropriateness and irrelevance of manual, large number of students, absence of well-trained lab-technician, inconvenient learning environment and etc. These problems undermine the quality of the experimentation in science education. Thus, the college and concerned bodies should address these problems jointly. Hence, the researcher forwarded based on the findings and conclusions, recommendations were made to alleviated the existing problems. Accordingly to minimize large number of students, hiring lab-technician and building alternative lab-rooms, equipped with sufficient chemicals, apparatus, equipment's and instructional materials, preparing relevant and appropriate manual, allocating budgets for laboratory to purchase important materials and other which were assumed to solve the identified problems were recommended.

Key words: Investigation, Practical laboratory, Major factors, Experimentation, Chemicals, Apparatus

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INTRODUCTION

No one is dispute that the practical laboratory work should occupy central position in a programme of science education (Yadav, 1996). Similarly Sharma (1998) mentioned that, learning by doing is one of the major principles of teaching science. Experiment is also the way of teaching science which is useful to minimize the problems that students face in their learning process. In addition to this Kumar (1995) indicated that most of the achievements of modern science are due to the application of experimental methods. Experiment is also the means by which students proof theoretical principles and facts they have thought in normal class. Kumar (1995) also mentioned that practical laboratory is helpful on brooding pupils experience and develops initiative, resourcefulness and cooperation.

Many science educators suggested numerous benefits of science laboratory activities to students (Garnett, *et al.*, 1998 & SCORE, 2007). Some of these benefits include increasing

students' interest and abilities in science subjects as well as their achievement in science (Pavesic, 2008 & Millar, 2000). Demonstrations, by instructors, can also be used as an option to support theories and lectures given in class rooms without adequate facilities to let students do the experiments by themselves (McKee *et al.*, 2007). However, as stated by Tobin (1990) and other authors, meaningful learning is possible from a given laboratory experiments if the students are given ample opportunities to operate equipment's and materials that help them to construct their knowledge of phenomena and related scientific concepts.

There are reports that emphasize teaching a science with the help of laboratory experiments to be more enjoyable and stimulating to students than teaching the same subject matter only through lecture (Hofstein and Lunetta, 2004). Use of laboratories also helps students to develop a positive attitude towards scientific research (Adams, 1942). Being one of the science subjects, Chemistry is being taught in all countries of the world regardless of their level development. It is offered to students of high school, college and university levels (Hofstein and Lunetta, 2004). Similar to other science subjects, teaching chemistry is also supported by laboratory experiments (Thomson, 1918). The original reason for development of chemistry laboratories was the need to produce skilled technicians for industry and highly competent workers for research laboratories (Morrell, 1969). Nowadays, however, chemistry practical courses are given not only to chemistry students but also to students in different fields that require specialized knowledge (Duckett, *et al.*, 1999).

Chemistry is essentially a practical oriented subject. No course in chemistry can be considered complete without including some practical work in it. For proper understanding of chemistry, it should be thought using a large number of demonstration experiments. For carrying out demonstration experiments and for the performance of practical by the students, a chemistry laboratory is a must for every school offering chemistry as a subject (Yadav, 1996). However, as Kumer (1995) stated that a special science room set aside for science faculties and materials is very desirable to an elementary school even where a self-contained program is conducted. Beside class-room, laboratory room that have facilities are needed to do experiment and for demonstration and project work.

According to Solomon and Negusse (2001) the general purpose of chemical experiment should be to give students some experience in using chemical knowledge, like other physical science, chemistry needs some experimental work at all level of educational institution which provides chemistry as independent subject including primary and secondary schools. Basically it is chemical science. The students should be able to do chemistry experiments, handle chemicals and apparatus, known procedures of specific experiment, observe analysis and interpret what is done and observed during experimentation. So that teaching chemistry without experiment is hazards or is not successful.

Chemistry experiments are believed to help students understanding theories and chemical principles which are difficult or abstract otherwise. Moreover, they offer several opportunities to students. Some of these opportunities include handling chemicals safety and with confidence, gain hands-on experience in using instruments and apparatus, develop scientific thinking and enthusiasm to chemistry, develop basic manipulative and problem solving skills, gain opportunities to students as investigators of the experimental work, identify chemical hazards and learn to assess and control risks associated with chemicals (Lagowski, 2002). It is important to note that designing chemistry laboratory experiments by itself is not a sufficient condition to achieve the desire objectives. It must be relevant. That is, it must understandable by students of a given education level.

Therefore, if chemistry studies are to progress, the college should be supported by laboratory which contain adequate facilities and materials. So, a factor that hinders chemistry laboratory in Asella College of Teacher Education has not been studied as far as

the knowledge of the researcher is concerned. This study is, thus, aimed at the investigation of factors that hinders chemistry laboratory experiments in Asella College of Teacher Education.

METERIALS AND METHODS

DESCRIPTION OF THE STUDY AREA:

The study area was Asella town which is found in Arsi zone, Oromia Regional State, Ethiopia. It is situated some 175 km from the capital Addis Ababa. Asella is situated at $6^{\circ}59'$ to $8^{\circ}49'$ N latitude and $38^{\circ}41'$ to $40^{\circ}44'$ E longitude in central Ethiopia (APEDO, 2007).

STUDY DESIGN:

Descriptive survey research method was employed for this study as it helps to gather a variety of data related to a problem under the study. So to have a clear picture on the existing problems and to accomplish the objectives a descriptive survey becomes appropriate.

SAMPLING TECHNIQUES:

Concerning the sampling techniques 2nd & 3rd year Chemistry department students were selected using simple random sampling. Because in simple random sampling every individual in the populations have the same chance of being selected for the sample. As to Kothari (2004) simple random sampling provides each and every items of the population equal chance of inclusion in the sample. Availability sampling would be employed to select chemistry instructors, laboratory technician and college management. Because, they are few in number and by virtue of the rich information they have about the study topic.

DATA GATHERING TOOLS:

Data sources in this study were based on the information obtained from primary data sources. The primary data was collected from 2nd & 3rd year Chemistry department students, laboratory technician, chemistry instructors and college managements in the study area. This primary data were obtained by using questionnaires, interviews and observation checklists.

STATISTICAL DATA ANALYSIS:

The method of data analysis was based on the type of instrument employed. In this study collected data were categorized as per their similarities. In addition, frequency and percentage were used to analyse quantitatively the data collected by questionnaires. Once the data is analysed, it interpret and discussed. Whereas data obtained from interview was transcribed and analysed to substantiate qualitative information. Data from observation were analysed to substantiate both qualitative and quantitative information. Finally, the major findings of the study were reported and realistic.

RESULTS AND DISCUSSION

LEVEL OF SATISFACTION AND RELEVANT OF CURRICULUM:

Majority of the respondents (instructors, lab-technician and students) (80%) of them were very interested (satisfied) in performing experiments of chemistry, while about 20% of them were no interested (dissatisfied). This is due to poor facilities of laboratory, inadequacy of equipment's and chemicals and there is no upgrading and modern in-service training on laboratory for lab-technicians.

Chemistry laboratory has specifically developed manual (100%). The manual was prepared both by college instructors (50%) and Oromia Regional Educational Bureau (50%). The prepared manual was not relevant to meet the curriculum, so it is medium

(50%). The relevance of the manual with students learning module was very low, it is about 33.3%.

TEACHING-LEARNING PROCESS, TEACHING LOAD AND CLASS SIZE:

Students perform laboratory in a group of 7-9 students in one group (100%). Thus, did not participate actively and all group members were not participating in lab-report writing (50%). This indicates that the students have not interest to perform experiments because of the large number of students in a group as well as experiments are most of the time done by lab technician/ instructor as demonstration. This is because of the result of unavailability of chemicals, materials and equipment's for each group in the lab room. The relationships among students, instructors and lab-technician were medium (50%) in terms of facilitating and implementing the experiments. This due to no enough facilities in the lab room and the room was too small to help each group.

The average ratio of lab-technician to students for one class was 1:50 (100%). This due to the absence of other laboratory classes and enough trained technician. But as Yadav (1996) noted that in case of a large class, it is convenient to divide the class in a suitable number of smaller groups, for experiments. A practical work group in no case should have more than 20 students. Teaching load of instructors besides laboratory work was about 66.67%. This means that majority of the instructors have class teaching of the theoretical parts beside the laboratory classes. So the laboratory work was not effectively performed (80%) due to the results of unavailability of instructional materials for experiments and teaching load.

AVAILABILITY OF INSTRUCTIONAL MATERIALS, INTERNAL FACILITIES AND STRUCTURAL ORGANIZATION OF THE LABORATORY:

Instructional materials such as chalk/marker, black/white board were available (60%) not adequately, whereas chemicals, apparatus, manual, were inadequacies (80%) and instructor lab-guide/syllabus was totally not available (100%). This indicates that there were shortages of most of instructional materials for the experimentation. During the materials, the Vice Dean of the college confirmed that there were no adequate chemicals and apparatus in chemistry lab. This understood from the view of the vice dean the college when he said:

There is a shortage of chemicals and apparatus for chemistry laboratory and adding, inadequacy of lab-manual has been one of the factors that hindered the experiments of chemistry.

Materials like stools and tables, water supplies, gas supplies, shelf and drawers, wash basin and sink, waste disposal, storage of chemicals and apparatus were available (60%) but not adequately. Glove and gown, dressing room, fire extinguisher, hood and first aid box were not totally available (100%). Regarding this, one of the college management responded generally, about the internal facilities of chemistry lab-room as:

It is fair in order to perform chemistry experiments but there is a shortage (scarcity) of different materials like apparatus for distilling water, fire extinguisher, chemicals, apparatus and other materials/ equipment's for chemistry laboratory.

Furthermore, both the process owners of human resources and finance head of Asella College of Teacher Education also shared the same ideas. This indicates that there was inadequacy with all materials and shortage of such materials in the market.

Concerning lab-environment, conformability of lab room for experimentation, arrangement of the stools and tables in lab, air conditioning of the lab room, arrangements of chemicals and apparatus and cleanness of the lab room were averagely medium (50%). This because of the lab room was not build according to chemistry laboratory standard. According to the data obtained through interview from Asella College of Teacher Education process owner of human resources replied that;

Chemistry laboratory experiments room is not conducive enough for the practice/implementation of the lab-work. This is because of chemistry laboratory room lacks a lot of things to implement different experiments.

WHILE PERFORMING LABORATORY AND IMPORTANCE OF LABORATORY:

Instructors and Lab-technician replied that time allotted for lab was somewhat enough and they support and give feedback to their students the way in which they gain the desired practical skills during performing laboratory. And also students replied that time allotted for lab work was good (68%), we get support and feedback (67.5%) from instructors and lab-technician was good and understandably of each procedure in experimentation was medium (50%). This shows that they gaining desired practical skills in some extent.

All respondents (instructors, lab technician and students) were strongly agree (100%) with the importance of laboratory work. Because of it provides theory with practical work, enables working in groups, an opportunity to engage deep learning, understand theoretical and chemical principles, develop the skills of lab reports and develop scientific skills. In order to supplement these points, the qualitative data obtained from one of the college management revealed that:

I think that, the importance of lab-experiments in chemistry is very important to understand the realities through experimental observation. The very nature of chemistry subject is a practical oriented. So that, it is very important as to realize the theoretical aspects.

Moreover, the data obtained through interviews with deputy dean of the college indicated that;

Practical work of chemistry provide students with sort of equipment's which help them to investigate scientific problems in order to understanding theories and principles of science laboratory.

On the open ended item in the questionnaires they described the importance of practical work in chemistry, they explained as:

Most of the achievements of modern chemistry are due to the application of the experimental method. They added, at college stage practical work is even more important. Because of the fact that individual "learning by doing" scientific principles and applications are thus rendered more meaningful.

LABORATORY CLASS PRACTICES/IMPLEMENTATION:

During Laboratory class lesson delivery such as instructor's lesson plan, gender equality, safety rules, continuous assessment used, arrangements of apparatus and chemicals, follow up students while performing experiments were totally (100%) not implemented as observed. This resulted ineffective implementation of the curriculum because in the condition were pedagogically recommended principles and guide lines were not practiced. In laboratory room instruction it is difficult to expect effective implementation of laboratory work. Concerning the plan of experiments and attendance taking during experimentation was totally (100%) implemented.

Laboratory class lesson delivery of observing flow charts of students, connecting lesson with prior knowledge and the overall laboratory class interaction are not done well and student's satisfaction are not as required (66.7%). whereas (33.3%) of it is done well and students satisfaction are somewhat good as observed

Concerning instructors/lab-technician adequate pedagogical, students participation, lab-management, lesson summarization by instructors were not adequately done (83.3%) while (16.7%) of them were done and also arrangements of chemicals and apparatus and subject knowledge of lab-technician is good (83.3%) while (16.7%) is not good as observed.

AVAILABILITY OF FACILITIES IN LABORATORY ROOM/CLASS:

From the checklist prepared for the purpose of the status of chemistry lab-room/class of Asella College of Teacher Education, one can see that almost all chemistry lab-room/class were not equipped and furnished with the necessary materials.

In short, the poor infrastructure reported above can have negative influence on the efficient and effective implementation of experimental work. Poor educational facilities could bring ineffectiveness of program implementation. In other words lack of basic facilities and resources needed in the chemistry room/class appear to have contribution to the ineffectiveness of the experiments.

Major Challenging Factors that Affect an Implementation of Laboratory

The implementation of any science experiment is affected negatively by internal factors such as absence of chemicals and apparatus, insufficient of equipment's, lack of sufficient time and well-trained manpower. Considering the factors that influencing the experiments of chemistry in Asella College of Teacher Education many of the respondents on the comment section of questionnaires and interviews forwarded many variety of factors associated with it.

1. Many of the chemistry instructors and lab-technician did not take in-service training which equips them with the necessary skills of performing laboratory work of chemistry in order to upgrade with modern chemistry experiments.
2. Chemistry laboratory internal and external facilities such as lab-environment, gas supply, water sinks, waste disposal, fire extinguisher, reference books, wash basin, first aid box, enough shelf and drawers, and etc were not available. And also arrangements of chemicals, apparatus, tables and stools were not well organized.
3. Unavailability of conducive facilities such as apparatus for distilling water, dressing room, first aid, alternative lab-room/class and separated toilet for boys and girls and etc.
4. Lack of budget allotted for the experiments of chemistry laboratory.
5. Unavailability laboratory materials in the market and complex nature bidding in order to purchasing the materials.
6. Large number of students in one laboratory room.
7. Lack of well-trained lab-technicians as the basic knowledge of the students.
8. Less basic knowledge of the students/trainees and less involvement of students in performing experiments and
9. While conducting chemistry laboratory less involvement of the students and all group members are not take part in writing lab-report equally.

CONCLUSIONS

Based on the Findings, the following conclusions were drawn:

The result of the study suggested that the students, lab-technician and instructors were interest of performing the practical work very highly. But due to the facilities and organizational structure of the lab-room/class it is difficult to conduct the experiments of chemistry.

Discussion with the respondents and information gathered through different tools identified that the experiments of chemistry are entangled with multiple problems. There were a serious shortage of apparatus, chemicals and other equipment's. These shortages were making the practical work of chemistry inefficient and ineffective.

Unavailability instructional materials such as manual, chalk/marker, black/white board, lab-guide/ syllabus were not as required level. This shortage leads to the practical work is not implemented as it intended in the curriculum.

Many of the chemistry instructors and lab-technician were not equipped them with the necessary skills of performing experiments of chemistry in order to upgrade with modern chemistry experiments. This was due to the absence of in-service training provided to them and lack of facilities.

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