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Full Length Research paper

Relevance and safety of Chemistry laboratory experiments from students' perspective: a case study at Jimma University, southwestern Ethiopia

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The main objective of this study was to gather students' opinion about the relevance and safety of Chemistry laboratory experiments. The study population of the study were undergraduate students majoring Chemistry, at Jimma University. The data were collected from randomly selected 123 students using structured questionnaires prepared in English. The result was analyzed (interpreted) using or based on calculated percentages. The results indicated that students in Chemistry laboratories are given opportunities to learn by doing i.e., self-practicing of experiments (62, 50.4%). Several advantages of Chemistry practical classes (experiments) were mentioned by the respondents. Some of the advantages were practical classes enable students in proper handling of chemicals and operating apparatus and instruments (42, 38.2%), data collection, interpretation and report writing skill (40, 32.5%) and developing attitude towards scientific research (36, 29.2%). Even though there are some complaints by students. Almost all the respondents (109, 88.6%) enjoyed laboratory classes offered by the Department. The group work currently employed in all chemistry laboratories are accepted by the majority (72, 58.5%) of the respondents. Organic Chemistry laboratory experiments were mentioned as potentially more dangerous than experiments in other Chemistry streams.

Keywords: Chemistry laboratory, Jimma university, self-practicing, chemistry laboratory experiments, Community-based education (CBE).

INTRODUCTION

Laboratory experiments (activities) are characteristic features of science teaching at all levels of education. They served as indispensable parts (components) in this regard since origin of the use of laboratory methods in science teaching long time ago (Hofstein and Lunetta, 2004; Blosser, 1980; Hofstein and Mamlok-Naaman, 2007; Abimbola, 1994; Borrmann, 2008; Fisher, 1998). Nowadays, it is rare to find any science course without a substantial component of laboratory activity in teaching institutions. During such laboratory experiments, students are provided with specimens or work guide (manual) and some sort of equipments which help them to investigate scientific problems in order to understanding theories and principles of science subjects. Many science educators (experts) suggested numerous benefits of science laboratory activities to students (Garnett *et al*., 1995; Hofstein and Lunetta, 1982; Lunetta, 1998; Tobin 1990). Some of these benefits include increasing students' interest and abilities in science subjects as well as their achievement in science (Bryant and Edmunt, 1987; Pavesic, 2008). Demonstrations, by instructors, can also be used as an option to support theories and lectures given in class rooms in institutions without adequate facilities to let students do the experiments by themselves (McKee, 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 equipments 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, 2004). Use of

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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 *et al*., 2004 and references cited therein; Yager *et al*., 1988). Similar to other science subjects, teaching Chemistry is also supported by laboratory experiments (practical sessions) (Reid and Shah, 2007; Adams, 1942; Thomson, 1918). The original reason for development chemistry laboratories (experiments) 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 (disciplines) that require specialized chemical knowledge (Duckett et al., 1999). Chemistry practical classes (experiments) are believed to help students in 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 safely 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; Pickering, 1987; Carnduff and Reid, 2003; Ravishankar and Ladage, 2009).

It is important to note that designing chemistry laboratory experiments by itself is not a sufficient condition to achieve the desired objectives. It must be relevant. i.e., it must be understandable by students of a given education level. There are two extreme thoughts regarding the importance of Chemistry laboratory experiments. The first one is that in traditional approaches, little opportunity is given to the student initiatives or circumstance. In this approach, all the laboratory procedures are carefully listed in the provided manual, and frequently the student is simply asked to fill in a well planned report template. At the end of a laboratory session, students have no real opportunity of understanding or learning the process of "doing Chemistry". The second one is that a student is given an opportunity to engage in deep learning (Gunstone and Champagne, 1990). This would provide an opportunity in identifying the main objectives of the work and in planning and executing it, of identifying the conceptual and practical difficulties encountered, recording and discussing the results and observations and of suggesting practical alterations and improvements (Teixeira-Dias *et al*., 2005). The latter, thus, could result in a significant positive impact n a students' ability to learn both the desired practical skills and also the underlying theory.

Regardless of all these facts (beliefs) of importance of laboratory activities in teaching science (chemistry), there are limitations. Some of them are (i) the objectives of the experiments are set by experts and academicians without any input from students. Thus, there are no ways to assess the relevance and understandabilities of the laboratory activities to students. This also creates a mismatch between the intended objectives of the practical works set by experts and students' need (Chang and Lederman, 1994; Wilkenson and Ward, 1997); (ii) Students are not allowed to conduct unauthorized experiments or experiments other than those listed in the manuals; (iii) due to resource demanding nature of laboratory experiments in terms of facilities and materials and also in terms of staff time (Carnduff and Reid, 2003), students are assigned to group work rather than individual work (Abdullah, 2009) that is expected to provide students with ample opportunities to "learn by doing" (Bruner, 1990). This could make control the activities and assessment of students' performances difficult. As a result, reactions of students to laboratory work (experiment) are often negative and this may reflect a student perception that there is a lack of any clear purpose for the experiments: they go through the experiment without adequate stimulation (Johnstone and Letton, 1988; Hofstein and Lunetta, 1982). Thus, it can be hypothesized that such limitations could be common problems in teaching chemistry at tertiary and secondary education levels in developing countries such as Ethiopia. This suggests the need to carry out a survey to collect students' opinion about the relevance (and limitations) of Chemistry laboratory classes (experiments). University students majoring Chemistry are appropriate candidates to gather such opinion since they are supposed to take several Chemistry practical courses.

Important point to be noted regarding Chemistry laboratories (experiments) is safety issue and environmental pollution that could be caused by chemicals used in those laboratories. Most of the chemicals are toxic, carcinogenic, explosive and flammable (or combination of these properties), and could cause human health hazards and environmental pollutions if they are mishandled or misused (Kan, 2007; Duffus and Worth, 2006; Draman *et al*., 2010). Employees (e.g., teachers and laboratory technicians) working in chemical laboratories and students are highly vulnerable to chemical risks (Anuar *et al*., 2009). Thus, it important to assess how the laboratories (experiments) are potentially dangerous and how much do the students are aware of these risks in order to make precautionary measures to avoid possible chemical-related accidents that can be prevented. This study was initiated to assess opinion of undergraduate students majoring Chemistry about the relevance of Chemistry laboratory experiments

offered to them as well as the safety of the experiments. The findings are discussed in the following sections.

Statement of the problem

As discussed in the introduction section, it is believed that practical chemistry classes (experiments) significantly help students to understand theories and principles of chemistry. Moreover, in addition to consolidating theoretical knowledge of students, practical courses help students to identify and solve problems, learn how to handle chemicals, operate different instruments and apparatus. They also help to develop students' scientific attitude and spirit of innovation in their future career. However, except offering practical Chemistry courses and providing prepared manuals, there are no attempts by institutions to collect feedbacks from students in order to assess the relevance of practical courses and safety of their laboratories. Thus, this study was initiated to investigate these issues at the Department of Chemistry, Jimma University.

Objective of the study

General objectives

- To investigate the relevance of practical Chemistry courses and safety of laboratory experiments.

Specific objectives

- To investigate the relevance of practical chemistry courses of the Department of Chemistry, Jimma University, based on Chemistry students' feedback.
- To gather students' opinion about the safety of laboratories used for practical Chemistry courses at the Department of Chemistry, Jimma University.

Significance of the study

To the best of our knowledge, there are no similar studies in Jimma and other higher institutions of Ethiopia. Thus, the findings of this study would

- provide information about relevance of practical Chemistry courses given at the Chemistry Department, Jimma University.
- help to improve situations in laboratories that could compromise the safety of students.
- serve as a baseline information for other researchers who want to conduct similar studies in other higher institutes.

METHODS AND MATERIALS

Study Area and period

This study was conducted in the Department of Chemistry, Jimma University. Jimma University is found in Jimma city which is located in the south western part of Ethiopia, and 346 km away from Addis Ababa, capital of Ethiopia. The University is known for its unique philosophy. i.e., community based education (CBE) (Mekonnen, 2000). In this program, students of the University regardless of their department and year of stay in the University must go to the surrounding towns and rural areas around Jimma city. The purpose is to enable students to identify problems of the community and prioritize them. Based on severity of the identified problems, the students make interventions to solve some the problems by mobilizing the community. Currently, it accommodates more than 20,000 students (at under graduate and post graduate levels) in its six colleges comprising of different departments. Chemistry Department is one of these Departments found in the College of Natural Sciences. It trains about 330 students at undergraduate and post graduate levels. The study was conducted from February to May, 2011.

Study population and sampling technique

The study population of this study was undergraduate students at the Department of Chemistry. During the study period, the total number of undergraduate students was 314. Of them, 115 were year I, 85 were year II and 114 were Year III. A standard sampling technique (Daniel, 2004) was used to determine sample size (Appendix I). Thus, the sample size was 123 (and 43 students from each batch). Sex was not considered as variable in this study since several reports claimed that there are no significant differences in performance of Chemistry practical skills among boys and girls (Deboer, 1987; Ssempala, 2005).

Data collection and analysis

Data was collected using structured questionnaire that were filled by randomly selected sample respondents of Chemistry Department. Brief discussions were held with the selected respondents about the objectives of the study and about the items listed in the questionnaire that was prepared in English. Then the questionnaires were distributed to them to collect primary data. The collected data was then manually tallied and percentages were calculated. Comparisons were then made and results represented in table form. Conclusions were also drawn based on the calculated percentages.

Table 1. The common ways of teaching-learning in Chemistry laboratory sessions (2011).

Common ways of teaching-learning	Year I *f*(%)	Year II *f*(%)	Year III *f*(%)	Total *f*(%)
Self-practicing	27(21.9)	20(16.26)	15(12.1)	62(50.4)
Both demonstration and self-practicing	9(7.3)	16(13)	24(19.5)	49(39.8)
Conducting experiments by reading manuals but without understanding the details	2(1.6)	3(2.4)	1(1.3)	6(4.8)
Only demonstration by instructors	3(24)	2(1.6)	1(1.3)	6(4.8)

*__f__ = frequency

RESULTS AND DISCUSSION

Common ways of teaching-learning in Chemistry laboratory classes

As discussed in the previous section (section 1), laboratory experiments are used to compliment class room lectures. They can be employed in two ways. These are demonstration by instructors and self-practicing by students. The later one is preferred over the former since it provides students an opportunity to "learn by doing" (Tobin, 1990; Bruner, 1990). As the results of the survey conducted in the study area (Jimma University) indicated that the majority of the students (62, 50.4%) disclosed that the common activities during Chemistry laboratory sessions proceed by self-practicing the experiments (by students) following the procedures given in manuals and brief introductions by instructors. Of these respondents, (27, 21.9%) were year I, (20, 16.3%) were year II and (15, 12.1%) were year III (Table 1). On the other hand, of 49 (39.8%) of the respondents 24 (19.5%) were year III, 16 (13.0%) were year II and 9 (7.3%) were year I responded that the common approach in teaching practical Chemistry courses is a combination of both demonstration by instructors and self-practicing of the experiments (by students) following the procedures given in manuals (Table 1).

The finding of the survey indicated that most of the time the common laboratory activities in Chemistry laboratory session (classes) conducted by self-practicing of the experiments following the procedure given in manuals and demonstration by instructors, and also by combination of demonstration and self-practicing. Moreover, the data also indicated that students from year I to year III are given similar opportunities to practice Chemistry experiments. These findings are consistent with the claims of educators stating that meaningful learning is possible in science laboratories only if students are given opportunity 'learn by doing' (Tobin, 1990; Bruner, 1990). It has also stated that in Chemistry laboratory, students become active in their learning by seeing, observing and doing. These laboratories also help not only in a better but also a permanent learning (Temel *et al*., 2000). Though students are given opportunity to learn by doing, they are usually assigned in groups that consist of five students/group due to shortage of facilities and resource. This made control of activities and performance of students difficult. Thus, objectives of Chemistry practical course such as increase students' ability to develop attitude toward scientific research, data collection interpretation and developing basic manipulative skills could not be achieved as expected.

Relevance of Chemistry laboratory classes (experiments)

Chemistry should be taught with appropriate emphasis on relevance to everyday life and its role in industry, technology, and society (Borrmann, 2008). An effective teaching-learning takes place only if students understand the objectives (relevance) of a given subject matter. However, almost all the objectives or laboratory experiments of Chemistry (and other sciences) are designed by experts or academicians of a given institutes without any participation of students. There are also reports indicating that students' opinion could be a valuable tool to assess relevance of laboratory experiments (Borrmann, 2008). Thus, participants of the study were requested to gather information about their opinion regarding the relevance (importance) of Chemistry practical courses offered to them. The result indicated that majority of the students replied saying the Chemistry practical courses (experiments) are relevant to them. The respondents also pointed out some advantages. Some of these advantages are gaining of skills in handling of chemicals, apparatus and instruments(42, 38.2%), data collection, interpretation and report writing skill (40, 32.5%) and developing attitude towards scientific research (36, 29.25%) (Table 2). The data also indicated that regardless of their years of stay in the University, the students could equally understand the advantages of laboratory experiments. The results are also consistent with the report by different educators and authors who claimed that laboratory (practical) classes in Chemistry teaching offer several advantages to students (Section1).

Table 2. Advantage of Chemistry laboratory experiments as claimed by respondents (2011).

Advantages of laboratory experiments**	Year I *f*(%)	Year II *f*(%)	Year III *f*(%)	Total *f*(%)
Handling of chemicals, lab apparatus and instruments	16(13)	15(12.1)	16(13)	42(38.2)
Data collection, interpretation and report writing skill	15(12.1)	12(9.7)	13(10.5)	40(32.5)
Developing attitude towards scientific research	10(8.1)	14(11.3)	12(9.7)	36(29.2)

*__f__=frequency; ** *multiple responses were possible*.

Table 3. Preferences (*group vs. individual work*) of respondents in conducting Chemistry laboratory experiments (2011).

Methods	Year I *f*(%)	Year II *f*(%)	Year III *f*(%)	Total *f*(%)
Group work	28(22.78)	28(22.78)	16(13.4)	72(58.53)
Combination of group and individual work	8(6.50)	7(5.69)	14(11.7)	29(23.57)
Individual work	5(4.06)	6(4.87)	11(9.24)	22(17.88)

*__f__ = frequency

Table 4. Responses given to "Do students enjoy Chemistry practical classes (experiments)?" (2011)

Batch/Response	Yes *f*(%)	No *f*(%)
Year I	36(29.3)	5(4.0)
Year II	38(30.9)	3(2.4)
Year III	35(28.5)	6(4.9)
Total	109 (88.6)	14(11.4)

*__f__ = frequency

The respondents were also requested about their preference (*group vs. individual work*) in conducting laboratory experiments. The collected data indicated that majority of the respondents preferred group work (72, 58.5%) followed by a combination both group and individual work (29, 23.6%) and individual work (22, 17.9%) (Table 3). These results indicated that the group work currently employed in all chemistry laboratories are accepted by students. It is important to note that students might give overly positive replies that do not reflect their true opinions when asked directly (Polles, 2006). Thus, different approaches need to be used to find more genuine responses regarding the relevance of Chemistry laboratory classes (experiments) in the Department. Despite, reported limitations associated with group work of students in Chemistry laboratories (Chang and Lederman, 1994; Wilkenson and Ward, 1997; Johnstone and Letton, 1988; Hofstein and Lunetta, 1982), from our experience (and CBE program of our institute) we believe that group work indeed help students to develop team spirit in problem identification and problem solving.

Biehler and Snowman (1986) reported that effective learning takes place when students are motivated. Thus, the respondents were requested whether they are enjoying the Chemistry practical classes offered to them. The results indicated that almost all the respondents (109, 88.66%) enjoyed the Chemistry laboratory classes offered by the Department (Table 4). This study is consistent with the report of Hegarty (1982) from Singapore who claimed that well designed laboratory classes are more enjoyable and stimulating than that of class lecture. Among the respondents, only 14 (11.4%) of them replied that they are not happy (or not enjoying) the Chemistry practical classes offered by the Department (Table 4). The reason given by these group of respondents were (i) these classes waste much of their time; and (ii) most of the activities are teacher centered (data not given).

Complaints of students about Chemistry laboratory classes

Due to individual differences, it may not be expected that all students equally enjoy the practical classes of Chemistry. Some students (as mentioned above) have

Table 5. Problems associated with laboratory classes (practical sessions) (2011).

Problems	Year I *f*(%)	Year II *f*(%)	Year III *f*(%)	Total *f*(%)
Values given to lab reports are not encouraging	10(8.1)	20(16.3)	12(9.7)	42(34.0)
Experiment carried out in group $\geq$ 5 students	13(10.5)	10(8.1)	15(12.1)	38(30.1)
Time allocation is not sufficient	10(8.1)	8(6.5)	10(8.1)	28(22.8)
Follow-up of instructor is low	8(6.5)	3(2.4)	4(3.3)	15(12.2)

*f = frequency

Table 6. Responses given to "Which laboratory experiments are dangerous and need extra precaution?" (2011).

Responses	Year I *f*(%)	Year II *f*(%)	Year III *f*(%)	Total *f*(%)
Organic Chemistry lab. Experiments	18(14.6)	16(13.0)	20(16.3)	54(43.9)
Inorganic Chemistry lab. Experiments	3(2.4)	14(11.4)	4(3.3)	21(17.0)
Analytical Chemistry lab. Experiments	8(6.5)	3(2.4)	5(4.1)	16(13.0)
Physical Chemistry lab. Experiments	5(4.1)	6(4.8)	2(1.6)	13(10.5)
No idea	7(5.6)	2(1.6)	10(8.1)	19(15.4)

*f = frequency

some complains about the relevance or the methodologies of laboratory classes. To find out whether the respondents have complaints or not, some items were includes in the survey questionnaire (Appendix II). The results obtained from the survey indicated that there are some problems or complaints associated with the Chemistry laboratory experiments offered by the Department. The major ones were (i) the values (marks) given to laboratory reports are not encouraging (42, 34.0%), experiments are carried out in a group of student consisting of ≥ 5 students (38, 30.1%), time allocation is not sufficient (22.8%) and follow-up of the instructors is low (12.2%) (Table 5). These data suggested that unless some immediate measures are taken, students may lose interest in chemistry practical classes in the long run. The data also indicated that there are similarities in the responses of the participants regardless of their stay in the university (Table 5). This observation also suggests the need of some corrective measures to minimize the aforementioned problems or complaints of students.

Safety of the Chemistry experiments and laboratories

As mentioned in the introductory section, most of chemicals and reagents used in Chemistry laboratory are potentially dangerous to students and employees as well as environment at large. To avoid such potential hazards (i) consistent awareness raising should be organized to all individuals (students and employees); and (ii) assess safety standards of chemical laboratories at a regular basis. In this study, a survey was carried out to gather information (opinion) from students about safety of the laboratories used and experiments offered in different streams the Chemistry Department. The result indicated that majority of the respondents (54, 43.9%) replied that experiments in Organic Chemistry laboratory are more dangerous than experiments carried out in the laboratories of other Chemistry streams (Table 6). The respondents also mentioned that most students are not as such comfortable in Organic Chemistry laboratory classes. Moreover, responses given by year I, II and III students were all similar.

This indicated that due attentions should be paid to Organic Chemistry laboratory experiments since most of the chemicals (reagents) used are volatile, explosive and flammable. But this doesn't mean precautions are not necessary in experiments of other Chemistry streams. For instance, significant number of respondents (21, 17.0%) also mentioned experiments in inorganic labs are also potentially dangerous. Since chemicals are not always friendly, equal attention should be given to all experiments in the Department to avoid factors that potentially compromise safety of the students and the surrounding environment.

CONCLUSIONS

It is well understood that laboratory experiences promote science education goals including the enhancement of students' understanding of concepts in science and applications, scientific practical skills and problem solving abilities. The methods of delivering practical Chemistry courses at Jimma University, self-practicing and combinations of self-practicing and demonstration, are consistent with those methods which are recommended by most science educators who advocate that meaningful

learning is possible in science laboratories only if students are given opportunity to actively engage in learning by seeing, observing and doing. Moreover, the group work which is commonly used in the Department has been accepted by the respondents. The survey of opinions of students on relevance of Chemistry laboratory experiments offered in the Chemistry Department, Jimma University, indicated that most students think chemistry laboratory classes are relevant and advantageous in their learning. However, some problems were mentioned by the respondents. Some these problems were low values to laboratory reports, absence of individual work (tasks), in adequate time allocation to laboratory experiments and low follow up of instructors. The opinions collected from students on safety of laboratories used indicated that Organic Chemistry laboratories (experiments) are relatively potentially dangerous as compared to the laboratories (experiments) in other Chemistry streams.

It is recommended that all the limitations suggested by the respondents should be given a due attention by the Department and the responsible authorities of the University to improve the teaching-learning process of practical Chemistry courses. Though group work is accepted by respondents, a combination of group and individual tasks need to be employed in teaching practical Chemistry courses. Moreover, the safety standard of all laboratories has to be assessed in a regular basis.

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Appendices

Appendix I

The statistical Daniel formula used to determine sampling size.

$$n = \frac{NZ^2PQ}{d^2(N-1) + Z^2PQ}.$$

Where n = sample of representative (Maximum Sample size)
N = Total population size = 314
q = Degree of confidence = 1-p
Z = Confidence interval (Standard normal variance (1.96) for 95%
P = Proportional population size (estimate prevalence or population) (0.5)
d = Standard error 1-0.95 = 0.05 interval 1-0.95 =0.05

$$n = \frac{NZ^2pq}{d^2(N-1) + Z^2(Pq)}.$$

$$n = \frac{314\ (1.96)^2\ (0.5) \times (0.5)}{(0.05)^2\ (314-1) + (1.96)^2 \times (0.5) \times (0.5)}. = 201.51 = 202$$

But 202 population size was very large for simplicity and time effectiveness the study was taken other reduction formula

$$nf = \frac{n}{1 + \frac{n}{N}}$$

Where n = Previously calculate simple size
N = Total Population
nf = Minimum final sample size

$$nf = \frac{.\ 202\ .}{1 + \frac{202}{314}}$$

= 122.922 = 123, thus, the sample size was 123 student.

Appendix II

JIMMA UNIVERSITY

COLLEGE OF NATURAL SCIENCES

DEPARTMENT OF CHEMISTRY

Dear respondents

The purpose of this study is to gather information from undergraduate students majoring chemistry, at Jimma University Chemistry, to assess relevance and safety of Chemistry laboratory experiments from students' perspective.

Instruction

Choose the appropriate response for each item and indicate your answer using mark " ✓ ". Please give only one response to each item.
Thank you.

1. Class: year I ☐ Year II ☐ Year III ☐
2. How many laboratory sessions have you attended so far?
   A. 1-3 B. 4-6 C. > 6
3. What are the common activities in your Chemistry laboratory sessions?

Appendix II cont.

A. Demonstration of the experiments by instructors
B. Self-practicing the experiments following the procedures given in manuals and by instructors.
C. Conducting the experiments reading manuals but without proper understanding.
D. A and B E. No idea

4. What advantages have you got from the laboratory experiments?
A. Handling of chemicals, and apparatus and instruments
B. Data collection, interpretation and report writing skills
C. Developing attitude toward scientific research D. No advantage E. No idea

5. Which way of conducting laboratory experiments is more advantageous?
A. Group work B. Individual work C. Both D. No idea

6. Are you (and your friends) enjoying Chemistry practical sessions (classes)?
A. Yes B. No C. No idea

7. If your answer for No. 6 is "No," what are the possible reasons?
A. Except repeating procedures given in manuals, no new knowledge can be learned.
B. I feel fear thinking that many of the chemicals used in the experiments may cause health hazard to me.
C. Waste much of students' time and most of the activities are teacher-centered
D. Most of the activities are not relevant (or not understandable)
E. The outcomes of the experiments are predetermined and do not motivate students
F. No idea.

8. What are your complaints about t chemistry laboratory classes?
A. The experiments are carryout in group consisting $\geq$ 5 students
B. The time allotted is not sufficient
C. The value (marks) given to laboratory reports are not encouraging
D. Follow-up of instructors is low
E. The way of reporting students' observation are not attractive

9. Do you (and your friends) think that laboratory classes helped you to achieve the desired skills and objectives?
A. Yes B. No C. No idea

10. If your answer to No. 9 is "No," what measures should be taken to help students to achieve the objectives?
A. Encouraging individual work and giving responsibility to each student
B. Encouraging group work
C. Giving more freedom to students to propose their own experiments
D. Reducing number of students in each laboratory class

11. Are the experiments safe to students?
A, Yes B. No C. No idea.

12. If your response to No. 11 is "Yes", which laboratory experiments are dangerous and need extra precaution?
A. Organic Chemistry Laboratory experiments
B. Inorganic Chemistry laboratory experiments
C. Physical Chemistry laboratory experiments
D. Analytical Chemistry laboratory experiments.