ENHANCING FIRST YEAR CHEMISTRY STUDENT'S PARTICIPATION IN PRACTICAL CHEMISTRY COURSE

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ABSTRACT

In this study, enhancing student's participation in practical analytical chemistry course at Haramaya University with various reasons was conducted. The data were collected from I year chemistry undergraduate students of class size 56 of which 23 were females and 33 were males. The class was arranged in to two groups for laboratory class and the experiment was conducted once per week in analytical laboratory. The research used mainly three kinds of data collection techniques namely questionnaire and laboratory report and demonstration result to gather the required qualitative and quantitative data for improving the participation of first year chemistry students. From the result, it was found that students were interested towards the practical analytical courses on the basis of condition such as, necessity of the chemistry with life, their participation in the laboratory, getting experience from the laboratory and performing the experiment in group. The results of the study support the notion that, students were more interested to a group work rather than individual work since they share idea, read their manual before coming to laboratory which contributed to their own participation in learning practical chemistry courses. The research has also shown that student's activity through experimental demonstration in group increases student's participations in the laboratory effectively by achieving better results than using laboratory report writing methods. The findings also revealed that some of the causes of students' negative attitudes towards learning practical Chemistry were mainly due to problems in preparing a flow chart for the experiments by themselves and lack of exposure to well-equipped laboratory for conducting demonstrations. In view of the findings and conclusions drawn in the study, Chemistry laboratories should be adequately equipped to ensure a smooth running of the practical classes and students should be encouraged to participate on practical chemistry courses and appropriate motivation should be given so that they will develop positive attitude towards the practical sessions. *[African Journal of Chemical Education—AJCE 6(2), July 2016]*

INTRODUCTION

One of the unique features of effective science teaching is laboratory work. It is a unique learning environment that is effective in helping students constructs their knowledge, develop logical and inquiry type skills and develop psychomotor skills. Laboratory work also has great potential in promoting positive attitudes and providing students with opportunities to develop skills regarding cooperation and communication [1]. Part and parcel of learning chemistry is carrying out laboratory practical. From an educational point of view, chemistry without laboratory work was seen as a body of factual information and general laws which conveyed nothing of lasting power to the mind [2].To this end, students are given ample opportunities to engage in scientific investigations through hands-on activities and experiments.

Several studies had shown that often the students and the teacher are preoccupied with technical and manipulative details that consume most of their time and energy. Such preoccupation seriously limits the time they can devote to meaningful, conceptually driven inquiry. In response, Woolnough [3] wrote that for these reasons, the potential contribution of laboratory experiences to assist students in constructing powerful concepts has generally been much more limited than it could have been. Such comments have been made often throughout the past 20years.

Tobin [4] wrote that “Laboratory activities appeal as a way of allowing students to learn with understanding and, at the same time, engage in a process of constructing knowledge by doing science”. This important assertion may be valid, but current research also suggests that helping students achieve desired learning outcomes is a very complex process. The inquiry approach, incorporating thinking skills, thinking strategies and thoughtful learning, should be emphasized throughout the teaching-learning process.

The science laboratory has always been regarded as the place where students should learn the process of science. Ideally, each student should be wholly responsible for conducting the experiments from start to finish. However, research has shown that teachers favored conducting practical activities in groups [5]. They reported that of the teachers surveyed, 54 percent reported group sizes of 4 or 5 students per group.

Direct observation of classes noted range of 1 to 7 students per group. The large group size limited active participation to 2 to 3 students per group, leaving the others as passive onlookers. This resulted in low level acquisition of scientific skills and knowledge among the students. According to Gunstone [6], using the laboratory to have students restructure their knowledge may seem reasonable but this idea is also naive since developing scientific ideas from practical experiences is a very complex process.

Gunstone and Champagne [7] suggested that meaningful learning in the laboratory would occur if students were given sufficient time and opportunities for interaction and reflection. Gunstone [7] wrote that students generally did not have time or opportunity to interact and reflect on central ideas in the laboratory since they are usually involved in technical activities with few opportunities to express their interpretation and beliefs about the meaning of their inquiry. In other words; they normally have few opportunities for meta-cognitive activities.

Students require the hands-on practical and personal laboratory experiences to acquire the science process skills; other problems associated with practical work in schools include the lack of facilities. One case study revealed that in general, equipment was adequate for group work in all schools for group sizes of 4 to 5 students [5]. In addition, research has revealed that in some cases students exhibited different attitudes toward school, in particular, biology, chemistry, and physics [8, 9].

Cheung [10] conducted a thorough and comprehensive review of the literature and found that over the years; only nine studies examined secondary school students' attitudes towards chemistry taught in secondary schools. He wrote that although these studies were informative, they produced mixed and inconsistent results. For example, Hofstein [11] conducted one of the studies among 11 and 12th grade students in Israel. Interestingly, they found that there was a significant decline in students' attitudes towards learning chemistry when they progressed from grade 11 to grade 12. On the other hand, in the USA, Milton [12] found the opposite, namely, that 12th grade students exhibited a more positive attitude than 11th grade students. One should note, however, that Hofstein [11] and Milton [12] used different attitudinal measures.

Many scientists and science educators are convinced that practical work must play an important role in learning science, but the reasons for its prominence are less clear. This lack of clarity lies in the vagueness of the questions asked about the role of practical work. Asking about the effectiveness of practical work for learning is like asking whether children learn by reading. The answer lies in the nature and contents of the activities and the aims which they are trying to achieve [13].

In a recent survey, 99% of the sample of science teachers believed that enquiry learning had an (83%'very'; 16% - 'a little') impact on student performance and attainment [14]. However, views about the role of processes in science education have been contested: some science educators have argued that practical work might help students to understand how scientists work, while others (see above) have argued that a process-based approach (that is, an approach that focused on experimental skills) was likely to lead to better understanding of science concepts.

Simpson [15] found that in general, laboratory work enhanced students 'attitudes towards learning chemistry. Ben-Zvi [16] reported on a chemistry study in which chemistry students wrote that personal laboratory work (hands-on) was the most effective instructional method that they had experienced for promoting their interest in learning chemistry when contrasted with group discussion, teacher's demonstrations, filmed experiments, and teacher's whole-class frontal lectures.

This study was carried out by assessing the present practice for active teaching learning participation of students of first year chemistry in Haramaya University for the practical analytical chemistry session to contribute for the betterment on the teaching leaning process and achievement of the intended objective of the practical course curriculum.

MATERIALS AND METHOD

Research Design

In an effort to combat the problem in enhancing students participation in practical sessions we began to develop a laboratory format in which each student in a laboratory group is assigned to participate in each practical experiment. The classroom format was arranged to allow for increased participation of student within the bench. Each bench was divided into two sub-groups. The teacher begins the class by introducing the experiment and short time lecture about theoretical aspect of the experiment. During group learning, students worked in groups of four students per sub-group on laboratory experiments.

The formation of sub-groups was assigned by the teacher rather than allowing student to pick their own lab partners. This helps to minimize the collection of less capable students who will typically have more difficulty with the laboratory exercise to the same group, because if we left them to pick their own lab partners, the student will pick other good students for their groups.

Students were informed that this teaching strategy was designed to increase their overall participation and success in the analytical chemistry laboratory.

Every week students were asked to submit their laboratory report and show a mini demonstration on their previous practical experiment which gave them the opportunity to express their participation about the laboratory activity in terms of the teaching strategy and overall understanding of the experiment (for both sessions to write report in a group of 4 and 8 students). Student surveys were then used as a means to determine whether or not the modified teaching strategies and curriculum were helpful to students and what future changes could be made through observation and interview.

In addition to class format students were allowed to fill the questionnaires prepared by the researcher concerning their activity and interest towards the lab course and main class course. The questionnaires were filled by both groups. The distribution of questionnaires was at the final end of the course that enables students to identify the part in which they were more interested and participate actively.

Population, Source of Data and Sampling

The target population selected were all chemistry undergraduate first year student at the department of chemistry who had registered for the course practical analytical chemistry. Only primary data source was used for this study which includes questionnaire, observation, students' laboratory report and demonstration result.

The data were collected from I year chemistry undergraduate students of class size 56. This research was done with one of our Chemistry 1st year classes at Haramaya University. In a class there were 56 students among them 23 were females and 33 were males. The class was arranged in to two groups for laboratory class and the experiment was conducted once per week in analytical laboratory.

Data Collection Procedures

The research used mainly three kinds of data collection techniques namely questionnaire, laboratory report and demonstration result to gather the required qualitative and quantitative data for improving the participation of first year chemistry students.

A questionnaire was issued to students to get the interest of those students toward analytical chemistry laboratory and to assess on increasing their interest. The questionnaires were filled by students. To achieve this objective the researcher took all first year chemistry students with a total size of 56. The questionnaires consisted of 20 items and distributed to all 56 students, out of which 23 were females and 33 of them were males.

The laboratory report result is used to assess the performance of students and used to measure the change they record when they write lab report in a group of 4 students per sub-groups and after they write the lab report individually for section I and section II in order to assess the effect of group size on participation of students.

Laboratory demonstration results were taken to assess student’s performance after they had conducted a 30 minute demonstration in their practical experimental sessions. Students were arranged in a group of 4 to present a demonstration of an experiment from their selected practical work and were evaluated through a systematic series of oral questions.

RESULTS AND DISCUSSIONS

Table1. Laboratory report results of the students after performing the experiment

Lab. Report (section I)	Range of Marks 50%	Lab. Report (Section II)	Ranges of Marks 50%)
In group of 4	33-38	In group of 4	33-38
In group of 8	42.5-43	In group of 8	41-44

Laboratory report results of the students after performing the experiment in a group of 4 and 8 students per each subgroup were recorded and the data obtained from their result is shown in Table 1. In contrast, students scored higher results (42- 43 marks) while they were arranged in group of 8 than they were arranged in a group of 4 students (33-38 marks) out of 50% of their total practical laboratory results which indicates students assigned in large group (a group of 8 students) showed better performance in their practical activities than in a small group of 4 students due to they shared more skills in interpretation, organization, deductions and recording of laboratory data easily. This implies that if they write report in a group, each individual need to observe and give attention to perform the experiment as much as possible in order to get good experimental data for the reports.

Table 2. Students' response for close ended type of questionnaires at appendix I

Q. No.	% A	% B	% C	%D	%E
1	11.1	66.7	11.1	0	11.1
2	22.2	11.1	11.1	11.1	44
3	0	22.2	11.2	44	22.2
4	55.6	22.2	11.1	11.1	0
5	33.3	11.1	33.3	22.2	0
6	22.2	55.6	0	22.2	0
7	55.6	22.2	11.1	11.1	0
8	11.1	77.8	0	11.1	0
9	66.7	33.3	0	0	0
10	44.4	22.2	33.3	0	0

Data obtained from the students' response for close ended type of questioners were shown in table 2 and 67% of students found that the learning environment in analytical chemistry laboratory were interesting. More than half of the students (56%) were interested to write a laboratory report in a group than individually. As can be shown from their responses (78%) of students have preference to perform experiments in laboratory class for each session in a small group rather than doing in large group which is contrary to their group organization at Laboratory report writing.

Generally, from the data response in Table 2 about student's activities in their analytical chemistry laboratory were helpful for the learning environment they made in their laboratory experience to make more meaningful by relating to what they discuss in class. Students have responded that they are very interesting towards the theoretical session of the analytical chemistry course (67%) and have a good interest in the practical laboratory course since they share something with in experimental class with a group of students and the teacher.

As can be seen from their response, 57% of the students were generally willing to write up their laboratory report in groups. The research indicates that learning without laboratory experience is meaningless in case of only the theoretical part of the course sessions since it couldn't be easily related to what they have discussed in class.

Table 3. The responses of students on the yes/no set of questions in appendix II

Question No.	Yes(%)	No(%)
11	66.7	33.3
12	22.2	78.8
13	100	0
14	22.2	78.8
15	88.9	11.1
16	77.8	22.2
17	44.4	55.6
18	55.6	44.4
19	60	40
20	80	20

Students response on the yes/no questions was recorded in Table 3, as can be seen from their response (100%), all students preferred to work on the practical sessions with partners or a friend by making an open discussion in a group time which is an indication of cooperative type of leaning is essential for the better performance of students in the practical analytical chemistry courses. Almost all students (80%) were interested to prepare a laboratory report in a standard format as stated in the laboratory manual after their laboratory session was going however 55.6% of the students were not interested to prepare flowchart before going to laboratory activities. The results of this study support the notion that, students were more interested to a group work rather than individual work.

Table 4. Laboratory demonstration result of students

Section	Range of Marks 20%
I(28 students)	**17-18**
II(28 students)	**16-18**

Students were arranged in a group of four to present demonstration of an experiment from their selected practical work and were evaluated through a systematic series of oral questions.This aspect assessed students' skills in problem identification, conducting of experiment, manipulation of equipment, hypothesizing, careful observation, interpretation of observation making of inference/deductions, organization and recording of data and effective communication. Laboratory demonstration results of students for experiment in a group of 4 students per each session were depicted in Table 4. As can be shown from the data all students have scored more than 80% of the mark when they perform experiment on demonstration schemes.

They scored better results if they work in group activities such as demonstration than individual experimental activities .This indicates that student's activity through experimental demonstration in group increases student's participations in the laboratory effectively by achieving better results than using laboratory report writing methods. This is because if they were evaluated through laboratory demonstrations each individual have an access to observe and give attention to perform the experiment as much as possible in order to get good experimental data. This implies that student' skills in conducting experiments, manipulation of equipment, measurement of volumes, careful observation, and control of variables and recording of data through demonstration is an effective way to enhance the performance of students in a group interactive method of learning.

CONCLUSIONS

This paper has revealed the participation of students towards the practical analytical courses. Looking at the findings in general, it was found that student's interest towards practical analytical courses was interesting on the basis of condition such as, necessity of the chemistry with life, their participation in the laboratory , getting experience from the laboratory, writing report in groups and performing the experiment in group. The results of the study support the notion that, students were more interested to a group work rather than individual work since they share idea, read their manual before coming to laboratory that contributed to their own participation in learning practical chemistry courses.

The research also indicates that learning without laboratory experience is meaningless in case of only the theoretical part of the course sessions since it couldn’t be easily related to what they have discussed in class. The research has shown that student’s activity through experimental demonstration in group increases student’s participations in the laboratory effectively by achieving better results than using laboratory report writing methods. The findings also revealed that some of the causes of students’ negative attitudes towards learning practical Chemistry was mainly due preparing flow chart for the experiments by themselves and lack of exposure to well-equipped laboratory for conducting demonstrations.

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REFERENCES

1. Hofstein A, Shore R, Kipnis, M (2004). Providing high school Chemistry students with opportunities to develop learning skills in an inquiry type laboratory: A case study. Intl. J. Sci. Educ. 26: 47-62.
2. Layton, D. (1990). Student laboratory practice and the history and philosophy of science. In E.H Hegarty(Ed),The student laboratory and the science curriculum. London and New York: Routledg.

3. Woolnough, B. E. (1991). Setting the scene. In B. E. Woolnough (Ed.), Practical science. Work in biology. International Journal of Science Education, 23, 985–1005.
4. Tobin K.G., (1990). Research on science laboratory activities; in pursuit of better questions and answers to improve learning, School Science and Mathematics, 90, 403-418.
5. Sharifah, M. & Lewin, K.M.(Eds) (1993). Insights into science education: planning and policy priorities in Malaysia. International Institute for Educational Planning, Paris.71.
6. Gunstone, R. F. (1991). Reconstructing theory from practical experience. In B. E. Woolnough (Ed.),Practical science (pp. 67–77). Milton Keynes: Open University Press.
7. Gunstone, R. F., & Champagne, A. B. (1990). Promoting conceptual change in the laboratory. the student laboratory and the science curriculum In E.Hegarty-Hazel (Ed.), pp. 159–182). London.
8. Osborne, J., & Collins, S. (2000). Pupils' and parents' views of the school science curriculum. London: King's College London.
9. Barnes, G., McInereney, D. M., & Marsh, H. W, (2005). Exploring sex differences in science enrolment Intentions: an application of the general model of academic choice, Australian Educational Researcher, 32, 1-23.
10. Cheung, H. P., & Lederman, N. G. (1994). The effect of levels of cooperation with physical science laboratory groups on physical science achievement. Journal of Research in Science Teaching, 32,167–181.
11. Hofstein, A., Ben-Zvi, R., & Samuel. D, (1976). The measurement of the interest in, and attitudes to, laboratory work amongst Israeli high school chemistry students, Science Education, 60,401-411.
12. Milton Keynes: Open University Press. Yager, R. E. (1984). The major crisis in science education. School Science and Mathematics, 84,189–198.
13. Wenger, E. (1998). Communities of practice: Learning, meaning, and identity. New York: Cambridge University Press.
14. Donnelly, J. (1995). Curriculum development in science: the lessons of Sc1, School Science Review, 76(227), 95–103.
15. Simpson R. D., & Troost, K. M,. (1982). Influences on commitment to and learning of science among adolescent students, Science Education, 66(5), 763-781.
16. Ben-Zvi, R., Hofstein, A., Samuel, D. & Kempa R. F., (1976). The attitudes of high school students towards the use of filmed experiments. Journal of Chemical Education, 53, 575- 577.

APPENDIX I

Questionnaires to be filled by undergraduate Year I Chemistry Students

Instructions: Dear students, we kindly request you to fill up these questionnaires without stating you personal details thank you in advance!!!

1. How do you find the learning environment in your analytical lab?
   a) Conducive to learning
   b) Somewhat helpful for learning
   c) I don't feel very comfortable
   d) Unfavorable atmosphere
   e) Doesn't help me in learning chemistry

2. Choose the change most important to you personally to make this lab experience more meaningful?
   a) I wish we had a place to work and ask questions.
   b) Demonstration of experiments.

c) Lectures with more participation.
d) Showing more application of chemistry to life.
e) Labs that related more to what we discuss in class.

3. How have you prepared for the lab part of this course?
a) I don't prepare before lab.
c) Make quick scan of the lab manual and write a pre-lab
b) I read the lab experiment.
d) Read the lab experiment, writes the pre-lab and calculation sheet.
e) Read the lab experiment and appropriate sections in the text, then prepare pre-lab and calculation sheet.

4. What was your practical analytical session's experience?
a) Very interesting c) unclear b) good d) poor e) totally irrelevant to my interests.

5. During and following lab. Sessions I write up discussions, interpretations and conclusions of the data from experiments.
a) Always b) usually c) sometimes d) rarely e) never

6. What is your feeling about writing lab report?
a) Better individually b) in a group c) while we are in lab class d) not necessary e) any other______________________________________

7. If report writing is in group what do you feel?
a) Very interesting b) good c) poor d) not necessary e) any other________________________

8. What is your preference to perform experiments in laboratory class for each session?
a) With large group b) with small group c) in pair d) individually

9. What is your feeling toward the theoretical part of this course?
a) Very interesting b) satisfactory c) good d) poor e) not interesting at all

10. What is your feeling toward the lab session of this course?
a) Very interesting b) satisfactory c) favorable d) poor e) not interesting at all

11. Did you share something with in experimental class? Yes/No

12. If yes, did you share with?
a)students only;
b)the teacher;
c)a group of students; or
d)a group of students and the teacher

APPENDIX II

Put tick mark on your choose

No.	Item	Yes	No
13	I like to do work with partners or a friend		
14	I like to work individually		
15	I like open discussion in a group time		
16	I like to participate actively in lab		
17	I like preparing flowchart before going to lab		
18	I like taking pre-lab quiz		
19	I like taking post lab quiz		
20	I like preparing lab report in a standard format stated in the lab manual after the lab is going		