STUDENTS' PRACTICAL PERFORMANCE-THE CASE OF PRACTICAL ORGANIC CHEMISTRY II COURSE: FLOW CHART PREPARATION

Shuma Fayera*[1] and Dereje Fedasa[1]
1. Department of Chemistry, College of Natural and Computational Science, Dambi Dollo University, Dambi Dollo, Oromia, Ethiopia
*Corresponding author e-mail: shumafayera2018@gmail.com

ABSTRACT

Practical work plays an important role in the teaching and learning of science and chemistry in particular to helping students to gain insight into scientific knowledge, skill and understandings. The research was conducted in Dambi Dollo University. To carry out the study a descriptive survey method was used. The major objective of this study was to offer an overview of the current situation in the course practical organic chemistry II of Dambi Dollo University. The sample consisted of all 20 second year second semester chemistry students, laboratory instructors and Practical Organic Chemistry II course material. The main instruments were questionnaires, content analysis of course material and observation. Qualitative and quantitative methods were employed to analyze data. The results indicated that the majority of the activities had lower inquiry level and the dominant practical work identified was demonstration activity. Laboratory instructors and students ranked the most important objective of the manual to demonstrate materials taught in lecture least. Based on these findings certain recommendations were forwarded. *[African Journal of Chemical Education—AJCE 12(2), July 2022]*

INTRODUCTION

Many students who have worked in a team in a laboratory or project-based course do not have fond memories of the experience. Some recall one or two team members doing all the work and the others simply going along for the ride but getting the same grade. Others remember dominant students, whose intense desire for a good grade led them to stifle their teammates' efforts to contribute. Still others recall arrangements in which the work was divided up and the completed parts were stapled together and turned in, with each team member knowing little or nothing about what any of the others did. Whatever else these students learned from their team experiences, they learned to avoid team projects whenever possible [1].

Laboratory activities have had a distinctive and central role in the science curriculum and science educators have suggested many benefits from engaging students in science laboratory activities [2]. According to [3], over the years, many have argued science cannot be meaningful to students without worthwhile practical laboratory experiences in laboratory. Unfortunately, the terms laboratory or practical have been used, too often without precise definition, to embrace a wide array of activities. Many arguments have been raised in the past to justify their use. But very little reason was given for their inclusion. Some laboratory activities have been designed and conducted to engage students individually, while others have sought to engage students in small groups and in large-group demonstration settings [4].

Students typically arrive at the laboratory to carry out an experiment without a very clear idea of the practical techniques they will be using, the skills they will need, or the chemistry which underlies the practical. It is usually only after the laboratory, during a write up, that students will start to work out what it was they had been doing all day. This is obviously an unsatisfactory experience and students will clearly get much more from their laboratory work if they know what they are doing beforehand. Pre-laboratory preparation is the key to achieving this and the laboratory skills philosophy has therefore been to shift the balance of work outside the laboratory to before rather than after the practical class so that students are much better informed and more confident [5]. As part of their pre-laboratory work, students are required to work through some background information about the experiment including sets of multiple choice and multiple completion tests which also provide instant feedback on any wrong answer [6]. Cooperative learning is an approach to group work that minimizes the occurrence of unpleasant situations and maximizes the learning and satisfaction that result from working on a high-performance team. A large and rapidly growing body of research confirms the effectiveness of cooperative learning in higher education [7].

Relative to students taught traditionally with instructor-centered lectures, individual assignments, and competitive grading cooperatively taught students tend to exhibit higher academic achievement, greater persistence through graduation, better high-level reasoning and critical thinking skills, deeper understanding of learned material, greater time on task and less disruptive behavior in class, lower levels of anxiety and stress, greater intrinsic motivation to learn and achieve,

greater ability to view situations from others' perspectives, more positive and supportive relationships with peers, more positive attitudes toward subject areas, and higher self-esteem [8]. Another nontrivial benefit for instructors is that when assignments are done cooperatively, the number of papers to grade decreases by a factor of three or four. The proven benefits of cooperative learning notwithstanding, instructors who attempt it frequently encounter resistance and sometimes open hostility from the students. Bright students complain about begin held back by their slower teammates; weak or unassertive students complain about being discounted or ignored in group sessions; and resentments build when some team members fail to pull their weight. Knowledgeable and patient instructors find ways to deal with these problems, but others become discouraged and revert to the traditional teacher-centered instructional paradigm, which is a loss both for them and for their students [9].

The pre-laboratory instructions have been employed for physics students and cooperative learning styles and laboratory reports also applied on different disciplines. This paper describes pre-laboratory flow chart instructions, cooperative learning methods that have been proven effective in a variety of instructional settings and post laboratory report writing with presentation. We then suggested ways to maximize the benefits of the approach and to deal with the difficulties that may arise when pre-laboratory flow charts are drawn for students to have awareness on the experiments, cooperative learning methods to build a teamwork spirit of students and managing ability on

practical organic chemistry II with report writing for to develop the scientific writing skills for their further career [10].

Practical works help students for the thorough understanding of the theoretical lessons that has learnt in the actual classroom. Practical works will enhance their comprehensive understanding and problem-solving skill of the subject matter although, the role of practical work as a part of science teaching and learning has varied in different countries at different periods of time [2]. Theoretical justification accompanied the inquiry approach which became dominant in science education, and field educators, for example, advocated that to develop a conceptual understanding of science; students must actively be involved in processing information [11]. Practical activities were seen as the sole means of providing this learning opportunity. The attributed outcomes of practical activities included (a) reinforcement of the understanding of scientific concepts and principles, (b) involvement in a number of handling and measuring skills and therefore promotion of the development of practical skills in students, and (c) involvement in problem solving and a "thinking style" that exposed students to the way of "working like a scientist" [6].

METHODOLOGY

The study population was Dambi Dollo University, Chemistry Department second year practical organic chemistry II class students. The study survey designed to use different assessment techniques in practical organic chemistry II laboratory class based on year two chemistry 2020 batch.

The design is intended to assess the usefulness of pre-laboratory flow charts and engaging all students in laboratory work and the effectiveness of group formation based on cooperative learning elements. In addition, this research was designed for the evaluation of post-laboratory report writing and presentation of the selected experiments as well as changing the attitude of female students for their further carrier in creating self-confident professionals of chemistry.

Sampling Techniques

All students of second year chemistry department (10 males and 10 females) in four cooperative learning groups for practical organic chemistry II were participated on this study. Students were randomly assigned to their groups.

Data Collection Instruments

The students used pre-laboratory flow charts, laboratory reports with presentation on the selected experiments, and post survey as the main instruments for collecting data. In order to gather information and facts through this instrument, check lists, criteria for report writing and presentation were prepared. Post survey questions were developed and distributed to all year two practical organic chemistry II class students.

Method of Data Analysis

Qualitative data collection techniques were used as the primary research methods. However, in order to organize, classify and analyze the gathered information, the researchers used mean, average and percentage statistics as a way to measure the students' level of improvement practical

skills through the use of flow chart check lists, criteria for report writing and presentation as well as questionnaire strategies. The main sources of information were the daily observation laboratory assistances and students during the practical organic chemistry II class. The "face to face" interactions gave us the opportunity to deepen into their experiences, thoughts, and feelings.

RESULTS AND DISCUSSION

Analysis of the Objectives of the Laboratory Manual

Much discussion today surfaced concerning the need to specify goals, aims and objectives for courses in higher education, especially to laboratory teaching. The statement of aims and objectives, in any course has importance for they provide significant implication as to how the course should be planned and structured. Most agree that when planning a course, care should be taken to ensure the consistency of course aims with that of the more specific objectives and the kind of experiences provided to serve the objectives.

Comparison of the course curriculum objectives with that of the major objectives of the manual does not reveal consistency. The objective of the course for practical organic chemistry was to familiarize students with basic practical skills. This was not consistent with the objective of strengthening the theoretical part of the course, which was the objective of the manual. It does seem very important that, for practical work to be effective, the objectives should be well defined. As it is indicated in when planning a course, it is crucial to state clearly the intended objectives: what to be

taught, and most importantly, what are the intended outputs of the course in a very clear way. According to undergraduate activities generally have two major purposes: they should give the student an opportunity to practice various inquiry skills, such as planning and devising an experimental program to solve problem, and an investigational work, which involves individualized problem solving, which is highly motivational especially if the student develops a sense of ownership for the problem. Through the analysis of the lesson tasks, it was discovered that the most emphasized objective of the laboratory work was as stated by the manual. Most lessons were demonstrations.

The concern of most of the laboratory lessons of the manual, as shown in table below, has been identified as the acquisition of basic organic chemistry concepts. This was manifested through a close relationship between the content of the course and the students' task in the laboratory. Such traditional view of science in school has exposed many of the students to failure and frustration. Apart from this they were identified as reasons for students' failure since they emphasized practical work as means of enhancing conceptual learning rather than acting as a source for the learning of essential skills. The most dignified aim of the course manual is to devote laboratory lessons follow closely to the theoretical part, clearly illustrate its assigned task and to make practice accommodating to theory.

Table 1: The emphasized aims in the Course Manual

No	Topics of the practical laboratory
1	**Experiment 1:** Preparation of p-Nitro aniline
2	**Experiment 2:** Acetylation of Aromatic-Amines: Preparation of Acetanilide
3	**Experiment 3:** Oxidation of Alkylarenes
4	**Experiment 4:** Azo Dyes and Ingrain Dyeing
5	**Experiment 5:**Kobel-Schmitt reaction: Preparation of β Resorcyclic Acid (2,4DihydroxybenzoicAcid)
6	**Experiment 6:** Esterification: Preparation of Amyl Acetate
8	**Experiment 7:** The Aldol Condensation and Cannizzaro Reaction
9	**Experiment 8:** Preparation of aldehydes and ketones by oxidation of alcohols
10	**Experiment 9:** Introduction to Proteins
11	**Experiment 10:** Introduction to Carbohydrates
12	**Experiment 11**: Polymers

The main aim of the course manual is to strengthen the theoretical part of the lesson.

Students' Reactions to Practical Organic Chemistry II Work

One of the questionnaires distributed among the students was lists of statements related to their experiences in Practical Organic Chemistry II laboratory activities. They were asked to what laboratory activity in Practical Organic Chemistry II.

Table 2: Mean student response to laboratory activity in Practical Organic Chemistry II

No.	Item	Mean
1	The opportunity given to plan my own experiment is very satisfying	4.80
2	Clear instructions are given about the experiment before doing the practical activities	4.80
3	Standard experiments, written up correctly, give confidence to continue with chemistry	5.00
4	Organic Chemistry laboratory should be about learning to do science through scientific investigations	4.87
5	It is always easy for me to see the point and aim of what I am doing and the importance of every laboratory activities	4.93
6	I feel most confident when the chemistry lessons were well structured and student directed	4.87
7	I appreciated the opportunity if the teacher lets me plan my own activity.	4.87

As shown in Table 2, the students responded above average and mid-point for most items which is 4.87. However, it was identified that students look difficulty to grasp the instructions of the experiment before doing the practical activities. Further it was found more satisfying and gave confidence if the lessons were well structured and student directed. On top of these most students wish organic chemistry laboratory to be a place where they could practice scientific investigations.

Students' and Instructors' Ranking of Lists of Objectives of Laboratory Activities

The other questionnaire distributed among students and laboratory instructors consisted of lists of aims of laboratory in science education and asked them to rank these lists of aims from the

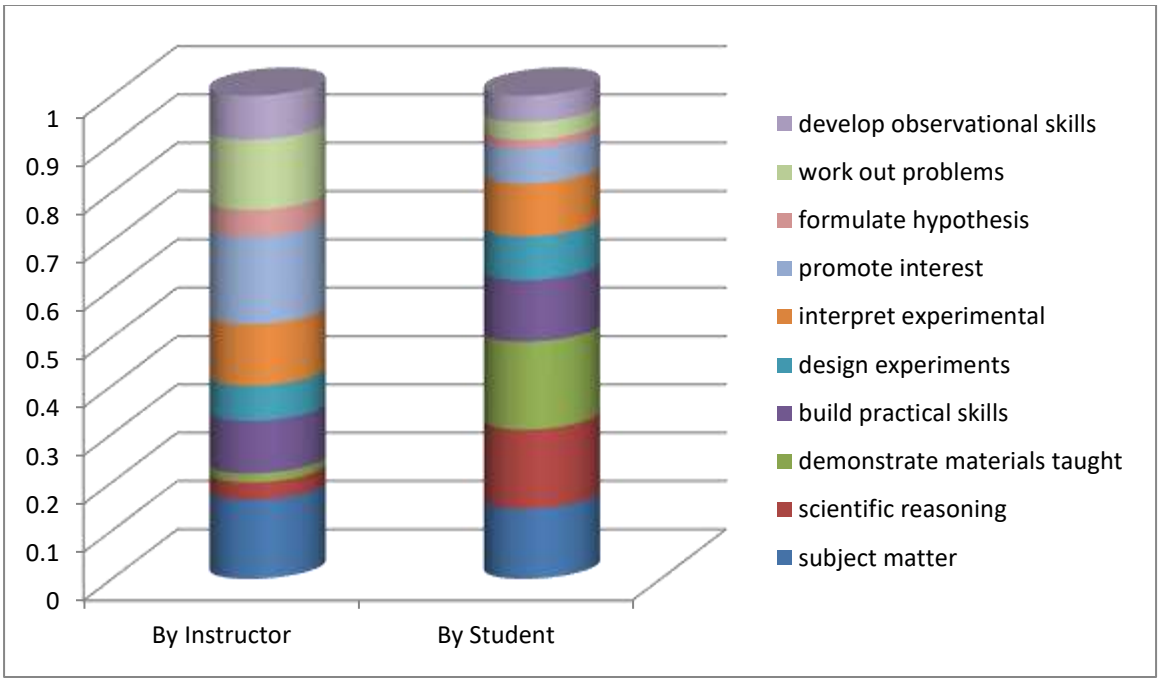
most important to the list important according to their interest. And their responses were summarized as shown in Table 3.

Table 3: Aims ranked from highest to lowest by instructors and students

N**o**	**Item**	**Rank given by most Instructors**	**Rank given by most students**
1	To improve mastery of the subject matter	Ninth	Eighth
2	To develop scientific reasoning	Second	Ninth
3	To demonstrate materials taught in lecture	First	Tenth
4	To build up practical skills	Sixth	Seventh
5	To design experiments to test hypothesis	Fourth	Fifth
6	To interpret experimental data	Seventh	Sixth
7	To promote interest in chemistry	Tenth	Fourth
8	To formulate hypothesis	Third	First
9	To work out problems	Eighth	Second
10	To introduce equipments and develop observational skills	Fifth	Thirds

The major objective of the manual, that is, to demonstrate the material thought in class (item 3), was ranked first by instructors and tenth by students. Moreover, the role of improve mastery of the subject matter (item 1) was rated low by both laboratory instructors and students.

The major objective of the manual, that is, to demonstrate the material thought in class (item 3), was ranked first by instructors and tenth by students. Moreover, the role of improve mastery of the subject matter (item 1) was rated low by both laboratory instructors and students.



SUMMARY

The major objective of this study was to offer an overview of the current situation in the course Practical Organic Chemistry II in Dambi Dollo University. All second year second semester chemistry students, laboratory instructors and Practical Organic Chemistry II course material provided data. The main instruments used were questionnaires and content analysis of the course material. Observation was also another instrument of data collection. Qualitative and quantitative methods were employed to analyze data. The data gathered from the students taking the course

Practical Organic Chemistry I through observations were analyzed qualitatively whereas the data gathered from questionnaires and content analysis were analyzed qualitatively and quantitatively.

Based on the basic research questions, the findings of this study are summarized as follows.

- The response to each question was given by the manual in almost all activities.
- Once students have the data collected, they write up formal laboratory report rather than discussing what was done. Apart from this, students were not giving due attention to the instrumentation and the way experiment is conducted.
- Most students think that the way objectives of the experiments are written is not clear to understand. Moreover, they face difficulty in understanding the importance of every laboratory activity.
- Students and instructors agreed that the most important objectives of a Chemistry laboratory work should be targeted in helping students to learn basic practical skills. Both groups ranked low the most important objective of the manual, to demonstrate materials taught in lecture.

In light of the findings and discussions made in the previous pages the following recommendations are forwarded:

- Each activity should be revised by deciding who is making the decisions: the teacher, text, or the student. There should be activities designed for goals other than teaching students' particular skills.

- Hence beside their role of strengthening the theoretical parts, other aims like to help students apply scientific reasoning, to test hypothesis, to formulate hypothesis and to work out problems should be included.

REFERENCES

1. Mabrouk P.A.. (2007). Active Learning: Models from the Analytical Sciences. *American Chemical Society, 970*, 34-53.
2. Hofstein & Lunetta. (2004). The laboratory in science education: Foundations for the twenty-first century. Science Education, 88, 28-54.
3. Heather F., Steve K., & Stephanie M. (2009). *A hand book for teaching and learning in higher education: enhancing academic practice.*
4. Belay Tafa. (2012). Laboratory activities and students practical Performance: the case of practical organic chemistry I course of haramaya university. AJCE, 2(3), 47-76.
5. Hofstein (2010). Development and implementation of inquiry-based and computerized-based laboratories: reforming high school chemistry in Israel. *Chemistry Education Research and Practice, 11*, 218–228.
6. Reid, N., & Shah, I. (2007). The role of laboratory work in university chemistry. Chemistry Education Research and Practice, 8(2), 172-185.
7. Johnson, D. W. and Johnson, R. T. (2013). *Cooperative Learning: The Foundation for Active Learning* (9 ed.). Minnesota, USA, University of Minnesota: Interaction Book Company.
8. Hofstein & Naaman. (2007). The laboratory in science education: the state of the art. *Chem. Educ. Res. Pract., 8*(2), 105-107.
9. Bransford J.D., Brown A.L., Cocking R.R., (2000). Committee on Developments in Science of Learning and Commission on Behavioral and Social Sciences and Education. How people learn: brain, mind, experience, and school. National Academy, Washington, DC.
10. Ligani shemsu, Baressa Anbessa & Bula Kere. (2016). Assesment of students' practical skill in laboratory: a case study of second year chemistry students of Bule Hora university Ethiopia. *International journal of for educational studies, 9*(1), 49-58.
11. Flavian Brian Fernandez. (2017). Action research in the physics classroom: the impact of authentic, inquiry based learning or instruction on the learning of thermal physics. *Asia-Pacific Science Education, 3*(3), 1-20.

APPENDIX

Questionnaire to be filled by second year chemistry students

Dear students,

This questioner gives you an opportunity to indicate your practical experience and reaction to the course practical organic chemistry II. Students' opinion is a valuable guide in the course planning and in evaluating the way it has been taught and the way the laboratory activities are carried out, So I kindly request you to respond to all the questions genuinely.

I appreciate your help in advance. Please write only your sex in the space provided _____

Direction I: the following are statements about what you did in your practical organic chemistry II laboratory session, you are kindly requested to rate each item on the scale shown to indicate your level of agreement. Please indicate your response by putting a tick mark in one of the boxes against each statement.

SA -Strongly agree, **A** -Agree, **UD** -Undecided, **DA** -Disagree and **SD** –Strongly disagree.

No.	Item	SA	A	UD	DA	SD
1	The opportunity given to plan my own experiment is very satisfying					
2	Clear instructions are given about the experiment before doing the practical activities					
3	Standard experiments, written up correctly, give confidence to continue with chemistry					
4	Organic Chemistry laboratory should be about learning to do science through scientific investigations					
5	It is always easy for me to see the point and aim of what I am doing and the importance of every laboratory activity					
6	I feel most confident when the chemistry lessons were well structured, and student directed					
7	I appreciated the opportunity if the teacher lets me plan my own activity.					

Direction II; the following are lists of aims for laboratory activities in science education; you are kindly requested to rank this list of aims from the most important to the least important.

No	**Item**	**Rank**
1	To improve mastery of the subject matter	
2	To develop scientific reasoning	
3	To demonstrate materials taught in lecture	
4	To build up practical skills	
5	To design experiments to test hypothesis	
6	To interpret experimental data	
7	To promote interest in chemistry	
8	To formulate hypothesis	
9	To work out problems	
10	To introduce equipments and develop observational skills	