A CASE STUDY OF USING SCIENCE LABORATORY IN TEACHING SCIENCE SUBJECTS AT THE HIGH SCHOOL LEVEL

Myint Kyaw Hein[1] and Khin Mar Khine[2]

Abstract

The primary purpose of the study is to investigate the science teachers' perception of using science laboratory in teaching science subjects at the high school level. Science laboratory is a setting in which the students work cooperatively in small groups to investigate scientific phenomena, a unique mode of instruction and unique mode of learning. The design applied in this study was the descriptive case study design. The sample size for this study was six science teachers from No. (1), BEHS, Hlegu and No. (1), BEHS, Mingalardon in Yangon Region. Triangulation, content analysis and cross site analysis were used to analyze the qualitative data such as interview, and observation records. The semi-structured interview and observation checklists were applied to collect the data. According to the result of the study, science teachers perceived that science laboratory had the impact on science teaching. Finally, discussion, and suggestions were provided for improving science teaching and learning at the high school level.

Keywords: Science Laboratory, Science, Perception.

Introduction

Science education is the most crucial factor in building a well-developed and modern country because this age is knowledge-driven age. Science knowledge explosion is more rapidly increasing in this century and science education is the most essential component of today education. Science is a process as well as a product of that process. Moreover, science process skills are important in exploring truth science products and science teachers must teach students to be coped with the basic science process skills. In addition, basic education is the foundation of higher education in which students may study depthfully specialized subject according to their interest. So, teachers must help students to fulfill basic knowledge and skills.

Science is a practical oriented work discipline and the laboratory is accompanied with every science subject. No course in science can be considered as complete without including some practical work. The science laboratory is the potential place where theory and practice can converge for students.

According to Tobin (1990), laboratory activities allow students to learn with understanding and engage in a process of constructing knowledge by doing science. Science laboratory has the potential to develop students' abilities and skills. In addition, science laboratory is the place where teachers can train students to be skillful in science process and gained basic science knowledge. Basic science teachers are the most important in teaching science at the high school level. According to Collette and Chiappetta (1989), inspiring and encouraging students to do well in school can be achieved through science activities and laboratories. According to Hofstein and Lunetta (2003), experiences in a laboratory can also help students to gain ideas about the nature of the science that are crucial for their understanding of scientific knowledge. Laboratory activities permit students to participate in investigations in which they do their own thinking and draw conclusions. Laboratory activities give students concrete learning experiences in which they can explore new ideas and relate concepts and theories to data gathered by personal observations (Hurd, 1964, cited in Collette & Chiappetta, 1989).

[1] Senior Assistant Teacher, No.2 Basic Education High School, Yankin, Yankin Township.
[2] Dr, Associate Professor, Department of Methodology, Yangon University of Education.

If a teacher believes that the laboratory work is important and has the competence and the scientific facilities, the students will frequently engage in laboratory activities that will reflect the philosophy of the teacher. If a teacher believes that the function of teaching science is to transmit information, the laboratories will be deductive in nature, occurring after textbook reading and classroom discussion. Thus, the laboratory will serve to verify existing knowledge. If the teacher believes that teaching science should be investigative in nature, then the laboratories will be inductive and will occur before textbook readings and teacher lectures and presentations (Pella, 1961, cited in Collette & Chiappetta, 1989). Nevertheless, promotion of science laboratory activity and practical work in school is increasingly a matter of concern. Science laboratory will have an impact on teaching science. Thus, the focus of this paper is to explore teachers' perception on the science laboratory in teaching science and the impact of science laboratory in students' learning at the high school level.

Purposes of the Study

The main purpose of the study is to explore the teachers' perception on science laboratory in teaching science at the high school level.

Specific purposes of the study are:

(1) To identify the impact of science laboratory on teaching science subjects.

(2) To find out the teachers' perception on teaching science in the science laboratory environment.

Research Questions

(1) How do teachers perceive on teaching science?

(2) Why do teachers use science laboratory in teaching science?

(3) How do science teachers deal with science laboratory?

(4) How do teachers perceive the impact of science laboratory in teaching science?

Scope of the Study

This study is geographically restricted to Yangon Region. Participants in the study are six science teachers who taught at Grade Nine and Grade Ten from No (1) B.E.H.S, Hlegu, Hlegu Township and No (1) B.E.H.S, Mingalardon, Mingalardon Township within the 2017 – 2018 academic year. Participants are selected by using purposive sampling method. Although there are many factors that impact on science teaching such as using teaching aids and electronic media, activity-based learning, concept map, and appliance of different science teaching methods, this study is restricted to the impact of science laboratory on teaching science.

Definition of Key Terms

Science laboratory: Science laboratory is a setting in which the students work cooperatively in small groups to investigate scientific phenomena, a unique mode of instruction and unique mode of learning (Hofstein and Lunetta, 1982).

Science: Science is a way of thinking in the pursuit of understanding nature, a way of investigating and a body of established knowledge (Collette & Chappetta, 1989).

Perception: Perceptions are the processes that determine how humans interpret their surroundings.

Review of Related Literature

According to the epistemology, the sources of knowledge gained are different. The empiricism stress that students gained knowledge from experiences, experimentation in pragmatism and learning by doing in constructivism. Science teaching is closely related to above philosophies. In this study, science knowledge has to be viewed as tentative human construction from the constructivist perspective.

Constructivism

Constructivism is a psychological and philosophical perspective contending that individuals form or construct much of what they learn and understand (Tonning 1990, cited in Leslie, 1995).

A basic assumption of constructivism is that people are active learners and must construct knowledge for themselves (Geary, 1995, cited in Leslie, 1995). To understand material well, learners must discover the basic principles for themselves. The teachers provide the appropriate materials and a social context within which the material is discussed but does not lecture or guide discussion in the traditional sense.

Another constructivist assumption is that teachers should not each in the traditional sense of delivering instruction to a group of students. Rather, teachers should structure situations such that learners become actively involved with content through manipulation of materials and social interaction. Activities include observing phenomena, collecting data, generating and testing hypotheses, and working collaboratively with others. Students are taught to be self-regulated and take an active role in their learning by setting goals, monitoring and evaluating progress, and going beyond basic requirements by exploring interests (Geary, 1995, cited in Leslie, 1995).

Constructivist Learning Environment

Constructivist environments should create rich experiences that encourage students to learn. According to Brooks (1990, cited in Lesie, 1995), there are some guiding principles of constructivist learning environments. One principle is that teachers should pose problems of emerging relevance to students, where relevance is preexisting or emerges through teacher mediation. Thus, a teacher might structure a lesson around questions that challenge students' preconceptions. A second principle is that learning should be structured around primary concepts. This means that teachers design activities around conceptual clusters of questions and problems. Third, it is important to seek and value students' points of view. Trying to understand students' perspectives is essential for learning activities that are challenging and interesting. This requires that teachers ask questions, stimulate discussions, and listen to what students say. Teachers who make little effort to understand what students think fail to capitalize on the role of their experiences in learning. Fourth, teachers should adapt curriculum to address students' suppositions. Some activities encouraged in constructivist classrooms are experimentation, research project, field trips, class discussion and so on.

Constructivism and Science Laboratory

Constructivism is an educational theory that emphasizes hands-on, activity based teaching and learning during which student develop their own frames of thought. Constructivist learning theory states that knowledge is constructed in the mind of the learner, and instructors cannot simply feed knowledge to willing recipients. Shiland (1999) applies five postulates of this learning theory to the laboratory environment. The first states that learning requires mental

activity. This application involves modifying experiments to encourage students to design parts of the procedures, identify variables and construct subsequent data tables. The second states that naive theories affect learning, and Shiland (1999) suggests moving experiments to the beginning of the chapter, allowing students to make predictions and explain them before the experiment. The third states that learning occurs from dissatisfaction with present knowledge, and experiments should be designed as problems to challenge this knowledge. The fourth suggests that learning has a social component that needs to be addressed through opportunities to discuss results and predictions with other students and instructors. Finally, the fifth postulate states that meaningful learning needs to connect theoretical principles with practical applications. All of these elements are part of laboratory-based learning, establishing a constructivist model of learning.

School Science Laboratory

The goal and purposes

Lunetta (1998) explained the objectives of laboratory activities as follows.

- Providing students with theoretical and conceptual information while learning natural science.
- Enabling students to learn science by helping them understand methods and nature of science.
- Enabling students to do science using scientific research procedures.
- Supporting students in a way that will help them define and put scientific theories into practice.
- Improving students' analytical and critical skills and encouraging them to be creative in science field.

The Laboratory as a Learning Resource

Laboratory work can be used as a powerful learning resource of science. Laboratory work is based on the principle of learning by doing and it is an integral part of science education. It helps in better understanding of various concepts of science and construction of knowledge. The first-hand experience obtained through experiment of knowledge. It imprints a permanent impression on the mind of the learners and provides opportunity to the teacher to inculcate various process skills of science such as observation, classification, analysis of data, recording, inferring, generalizing and communicating. Process skills required help in developing interests, values, and spirit of inquiry that constitute scientific attitude. Students learn while handling, manipulating and innovating different types of equipment. It provides an environment to learners for exhibiting their qualities such as resourcefulness, initaitiveness, orderliness, cooperation, and team spirit. Students enjoy working together with their peers with some freedom of action, having a feel of excitement of the unknown and achieving a sense of discovery. Learners cannot discover all of science; however, encouraging them to observe, investigate and think critically on a laboratory activity can facilitate them to construct some abstract concepts and principles of science, to awaken curiosity about the world around them and to gain a feel and appreciation of science. Thus, laboratory work facilitates development of (i) cognitive abilities, i.e. principles and laws discussed in the classroom may precede or follow the laboratory work or it may be carried out during discussion; (ii) process skills of science; (iii) scientific attitude; and

(vi) understanding nature of science. Use of laboratory must be focused towards achieving these developments.

The kind of experience that is provided by the laboratory cannot be replaced by any other exercise. Well-planned laboratory experiences have great potential to attract students.

Common Characteristics of Science Laboratory

Laboratory guide book or manual is designed to identify problems requiring observations and solutions. Laboratory assistant helps science teacher to maintain and organize the equipment and supplies. The directions for laboratory exercises must be explicit. They can be given orally or in written form or discussed during the pre-laboratory session.

Auxiliary record book - Observation of the experiment performed should be recorded in it. Discussion in laboratory includes pre-discussion and post-discussion.

Effectiveness of the laboratory experiences is directly related to the amount of individual participation by students. Individual participation means active involvement in the experiment with definite responsibilities for its progress and success.

Approaches to Laboratory Work

Verification or Deductive Laboratory

The verification or deductive laboratory is the most common approach to laboratory work in science courses. The purpose of this type of laboratory work is to illustrate concepts, principles, and laws. Teachers generally present major ideas first, through lecture, discussion, and reading, followed by laboratory work to illustrate and verify ideas using concrete activities.

Inductive laboratory

The inductive laboratory provides students with the opportunities to form concepts, principles, and law through firsthand experiences before they are discussed and taught in the classroom.

Science Process Skill Laboratory

A major purpose for including laboratory work in science courses is to present science as a way of investigating and as a way of thinking. Science process skills include basic skills; observing, classifying, using space/time relations, using numbers, measuring, inferring, predicting, and integrated skills; defining operationally, formulating models, controlling variables, interpreting data, and experimenting.

Technical Skill Laboratory

Good laboratory techniques are essential to conduct successful laboratory activities and to collect accurate data. They require manipulative skills that involve the development of hand-eye coordination.

Exploratory Laboratory

Science teachers allow their students to explore an idea, concept, principle, or theory without structured procedures. In an exploratory laboratory students are given the freedom to explore and test ideas.

Laboratory Instructional Styles

	Descriptor		
Style	**Outcome**	**Approach**	**Procedure**
Expository	Predetermined	Deductive	Given
Inquiry	Undetermined	Inductive	Student generated
Discovery	Predetermined	Inductive	Given
Problem-based	Undetermined	Deductive	Student generated

Source: from J. J. Lagowski, (2002).

Science Teaching Methods.

Science teaching methods are lecture, demonstration, discussion, laboratory method, project and problem solving.

Method and Materials

The study is aimed to explore the high school science teachers' perception toward science laboratory in teaching science. Teaching science is not interesting without laboratory. Teaching science is always accompanied with science laboratory. In every science curriculum the laboratory work is included. This study was conducted by using interview and observation methods.

Research design and procedure

This study is a descriptive case study by using interview and observation techniques. Descriptive case study focuses on thick description of whatever is being studied. Thick description may be defined as the complete and literal description of the entity investigated. This study used the semi-structured interview to explore teacher's perception and naturalistic observation checklists to watch the teacher's performance during the laboratory instruction.

Firstly, the relevant literature is studied. In order to get the required data, the instruments were developed. Content validity was determined by expert judges. After preparing the required interview questions and checklists, pilot testing was done. During the interview procedure, audio-recorder and note taking were used to record the data. The interview takes an average of twenty minutes. During the observation procedure, checklists were used to observe teachers' performance during laboratory instruction and to detect the physical appearance of science laboratory. According to the pilot study, the interview questions were modified by repairing the wording and added the other facts needed to ask. After the pilot study, the main study was executed during the last two weeks of November in 2017 – 2018 academic year. The modified instruments were interviewed to the selected participants of the two sample schools and the data were analyzed.

Instruments

The interview was conducted by using semi-structured questions (see Appendix A). These questions were constructed based on Ayse, G. K. and Zengin, R. 2015. The interview consists of six components. Two types of observation checklists were created. One is aimed at investigating the teachers' performance during teaching science in science laboratory. This checklist was developed based on the procedure of laboratory method and demonstration method of Belen, 1962, cited in Garica, 1989, (see Appendix B2). Another was established to describe the physical appearance of science laboratory (See Appendix B1).

Population and Sample size

This study used the purposive sampling method and it was conducted in the North district of Yangon region. Participants were selected from one of the high schools in Mingaladon Township and from one of the high schools in Hlegu Township. This study was implemented during 2017 - 2018 Academic year. It takes about two weeks.

Data Analysis

The modified questions were interviewed to six participants from the selected schools. Qualitative data were collected from the teachers' response of interview and performance from checklist. The record of the interview was translated into a scripts as important reference for encoding. The observation was noted descriptively and reflectively. The data were analyzed by using triangulation method, content analysis and cross-site analysis method.

Findings

Demographic Factors of science Teachers

The science teachers are from thirty to fifty nine years old. They are bachelor and master degree holders. Their total teaching services are about eight years to thirty years. They teach science twenty four periods per week. The range of science teaching services is at least four years to at most twenty six years.

Science Teaching

Most science teachers apply explanation (lecture) and demonstration methods in science teaching. They employ direct instructional strategies. Teachers aim students to understand the lesson clearly and apply knowledge and formula in problem solving at examination. They only look forward students to pass examination outstandingly. They aim to increase pass percentage range of examination (See Appendix C). Teachers' difficulties are insufficient conditions of laboratory equipment, materials, chemicals and teaching aids. They cannot show real objects for every lesson. Teachers solve these difficulties by showing relevant photos and videos that are downloaded from internet and Facebook instead of real objects (See Appendix C). So, teachers apply technology in science teaching. Teachers' technology skills are important in today science teaching. Another difficulty is that some students are weak in Mathematics and Basic English skills.

Teachers are really interested in science teaching because science is related to the nature and environment and scientific knowledge can be applied in real life. Science teaching includes practical and discovery work. Teachers are satisfied with science teaching. They thought that science has no fictional character and it is pragmatic.

Appliance of Science Laboratory

There is only one science laboratory in No.1, B.E.H.S, Hlegu but No.1, B.E.H.S, Mingalardon has three science laboratories. Teachers apply science laboratory in science teaching. Because of appliance of science laboratory, students can execute practical work and observe demonstration. They can easily understand, memorize, retain and remember the lessons lastly. They are interested in experiment. Practical equipment can only be systematically stored in science laboratory. Teachers have known that science laboratory assists students to learn lessons easily. Performing experiments can identify that theory is true.

Doing Laboratory Work

Teachers aim that doing laboratory work can improve students' thoughts and comprehension about the lessons. Students will illuminate lessons explicitly. Because of practical experience, students can make reasoning for everything (See Appendix C). Teachers comprehend that science laboratory is a learning resource. Teachers think that science laboratory is absolutely necessary for science teaching because students learn effectively and remember the lesson. Explanation of lessons by showing real objects is necessary for students' understanding. Students' investigative and creative abilities can be developed. It can concluded that science teachers' purpose of doing laboratory work is to facilitate development of cognitive abilities and process skills of science. Teachers taught in science laboratory according to the practical course relating to the lesson. Teachers performed convenient laboratory work. Laboratory work is not performed for every lesson (See Appendix C). The laboratory work is not systematically recorded in books. Teachers are weak in doing laboratory work. In site one, laboratory assistant helps teachers to perform experiment by preparing required materials and equipment for demonstration. She stores the laboratory equipment and materials systematically. But in site two, laboratory assistant does not help teachers. Nevertheless, laboratory assistant should help science teachers to maintain and organize equipment and supply for the preparation of laboratory and demonstration.

Teaching Methods and Approaches Applied in Science Laboratory

Teachers use demonstration, laboratory, cooperative and discussion methods in science teaching at science laboratory. They apply question and answer techniques and observation techniques. Teachers apply direct and indirect instructional methods. They can use variety of teaching methods in science teaching at the science laboratory but classroom situation must be interactive.

The four science teachers apply science laboratory after lesson. Those teachers execute verification or deductive laboratory work. Teachers thought that without knowing theory and procedure, students do not understand how to perform experiment. After they have known them, they can verify that theory is true by performing laboratory work themselves (See Appendix C). But two science teachers apply science laboratory before lesson. Those science teachers execute inductive laboratory work. Before lesson, doing laboratory work by students improve their understanding (See Appendix C). Teachers employ inductive and deductive approach in science teaching.

Implementation of laboratory work

Teachers implement laboratory work by working together each other. They draw practical schedules and prepare experiment themselves. Teachers' cooperation is important to execute the laboratory work. Teachers determine the laboratory procedure by asking opinions from partners. Based on the method they applied, they also determine the laboratory procedure. Four science teachers employ teacher-led demonstration method. So, they use the laboratory procedure such as purposing, proper demonstration, executing and evaluation. Two science teachers employ laboratory method. So, they use laboratory procedure such as lesson introduction, predicting and overview of activity, performing experiments and closure. It can be interpreted that four science teachers mainly apply expository laboratory instruction style. Two science teachers employ discovery laboratory instruction style. Teachers assess students' laboratory work by giving A, B

grade on practical book. They also check students' understanding by asking questions. The practical marks are not needed to count for final exam result. So, they only check the practical paper whether students get the right results (See Appendix C).

Teachers favour to implement group laboratory work because time is not enough to do individual laboratory work and the laboratory books are not sufficient. Because of group laboratory work, students can give their opinions to each other and they can work cooperatively together (See Appendix C). Teachers create science laboratory as a place in which students work cooperatively in small groups to investigate the phenomena. Although social interaction in laboratory is paramount, individual participation is also important in science laboratory work. Teachers approach students by using questioning and observation techniques in teaching laboratory work. They explore background knowledge of students by asking questions. Their approaches are formal. It should include discussion because science laboratory work includes pre and post discussion. Teachers' problems are that the required laboratory equipment and materials are not sufficient and enough to implement laboratory work. They are weak in knowledge to do practical experiment. The laboratory materials are old, faded and needed to be repaired. Teachers solve these problems by applying replaceable materials that are easily got from environment. Teachers' pedagogical knowledge and creative abilities are important to become successful teaching – learning process in science laboratory. Teachers have no laboratory manual but they have laboratory work book. They study the procedure in the work book and implement them. Teacher's manual for science laboratory is absolutely necessary because without knowing the procedure, effects of chemicals and limitations of experiments, and how to apply instruments, teaching science in the laboratory cannot be successful. The head of the school supports the laboratory equipment that are given by Ministry of Education. Four science teachers attended practical course at West Yangon University. This course takes only one day. The dean of subject has a chance to attend this course. They get a lot of new required knowledge from this course. The practical course is absolutely necessary for all science teachers.

Practical Experiment

Teachers thought that practical experiments make science teaching more interesting. Since students perform and observe experiments themselves, scientific knowledge, facts and concepts are firmly attached in their memory. Teachers said that science teaching without practical experiment is like story telling (See Appendix C). Practical experiments play a main role in science instruction. Four science teachers favour student-led experiments. Two science teachers prefer teacher-led experiments. But in reality, teacher-led experiments are performed because of incomplete situation of materials and apparatus. Teacher-led experiments are convenient if students have limited amount of scientific knowledge to do experiments well. Teachers thought that students can easily understand the lesson, remember the important facts and identify that theory is true by performing practical experiments. Practical experiments are suitable with students' learning. Science teaching with practical experiments help students to learn lessons easily. Teachers believe that the practical experiment is related to students' learning theoretical lesson because students can easily memorize the lessons and retain them lastly when they perform and observe the experiments (See Appendix C). Science includes facts, concepts, theory and law. Without practical science teaching may be unsuccessful. Nevertheless, teachers who have positive scientific attitude and creative spirit can create complete science laboratory environment in which students will actively learn by performing practical experiments. Teachers assume that there is a significant difference in students' learning between doing science experiment and conventional teaching. Students interest to perform practical experiment. But in conventional teaching, students may be lazy and not interested in lesson. Practical experiments have positive effect on students' learning and their interest.

Perception toward Science Laboratory

Teachers believe that science laboratory has impact on students' learning because students easily recognize and remember the lessons when they perform laboratory work (See Appendix C). Teachers suppose that practical experiments are much enough to concretize abstract knowledge for students. Students have difficulty to understand the theoretical lessons that are abstract. Practical experiments confirm that theory is true. So, students' abstract knowledge can be transformed into concrete. Teachers believe that students can apply knowledge gained through learning in science laboratory as a basis for next grade. The scientific skills and ways of problem solving can be applied in real life situation (See Appendix C). So, teachers have to teach students to develop scientific thoughts, attitudes and skills by the use of laboratory work. Teachers assume that science teaching in the laboratory progress students' learning and active participation because students work together to get the right result of experiment and they also ask investigative questions. Science laboratory should be a place which can progress students' learning by allowing them to perform practical experiments cooperatively with each other. Teachers like science teaching in science laboratory and interest to do experiments. Science practical work is related to the environment. Students' thoughts, affiliation and confidence can be improved by teaching science in laboratory. Teachers who have positive attitude toward science laboratory may design experiments even without complete situation of laboratory equipment.

Discussion and Conclusion

Discussion

This study is to investigate the teachers' perception towards the science laboratory in science teaching. In the research of Kozcu (2006), he described that laboratory based learning has a much greater effect on students' academic success, level of memory and their sensibility than the formal teaching. In this study the teachers perceive that science laboratory activities assist students to learn lesson easily. Science laboratory has positive influence on science teaching in which students can easily understand, lastly retain and remember the lessons. Trowbridge and Bybee (1990) suggested that in reality, the maximum learning may be achieved, for certain students, by working in pair or small group activity may be beneficial. This result is agreement with this study. Teachers thought that students can give opinions and work cooperatively because of group laboratory work. They asserted that the group work is time saving approach. In the research of Prachanent and Chaivisthungkura (2016), they asserted that problems of lacking basic science laboratory equipment result students have no chance to do experiments. To enable the complete contents, teachers used the video clips involving experiments. Comparatively, the research found that most science laboratory equipment are faded, old and are not enough for all students. Teachers apply replaceable materials that are easily got from environment. They also show the relevant pictures and videos that are downloaded from the internet.

The laboratory guides or manuals and instruction must develop students' conceptual understanding, creative thinking, problem solving activity, and scientific thinking (Pavelich and Abraham, 1979). In this study, teachers have no laboratory manuals. They have laboratory work books. They implement laboratory work by asking opinions from each other. Four science teachers applied verification or deductive laboratory approach and two science teachers used inductive laboratory approach. According to (Renner, 1986), in good laboratory, students discover concepts: they do not just verify them. Science teaching should include both approaches.

Laboratories are crucial making abstract concepts concrete (Pekmez, 2001, cited in Sample, 2011). In this study teachers perceive that students' abstract knowledge can be transformed into concrete because of performing practical experiment which can verify that theory is true. Learning can be more meaningful by the manipulation of objects such as in the laboratory and through the use of pupil experiences and interest. This statement supports with this study's results. Teachers perceived that laboratory activity broadens interest of students and science students can see and confirm things in the textbook. Moreover, when the students handle themselves in the experiments, experience is impressed more trimly on their minds than when they listen or see from distance. They prefer student-led demonstration. But, in reality, teacher-led demonstrations are performed.

According to Bybee (2000), the school laboratories have the potential to be an important medium for introducing students to central, conceptual and procedural knowledge and skills in science. The findings of this study confirm Bybee's statement. Teacher believed that knowledge gained though science laboratory can be applied in the next grade. The scientific and problem solving skills can be also applied in real life situation. According to Freedman (1997), laboratory work is an effective learning environment for enhancing attitudes, stimulating interests and enjoyment and motivating students to learn science. Teachers asserted that students' thoughts, affiliation, and confidence can be improved by teaching science in laboratory. Laboratory work has impact on students' learning and improve students' participation because they perform experiments. Their inquiry and investigative spirits are evoked.

Suggestions

Science teachers perceived that science laboratory has impact on science teaching. Science laboratory activities motivated students to learn by doing individually or in a small group. According to the results of the study, the suggestions are given as follows.

a. In order to make use of laboratory effectively which is essential for science instruction, the perceptions of science teachers and students need to be considered for necessary regulations and developments of laboratory work.
b. Teachers should systematically and regularly implement the laboratory work.
c. Teachers should provide the direct experiences in science where students are curious, energetic and resourceful.
d. Experimental activities should improve scientific thought and problem solving skills so that students can develop positive attitude in science learning.
e. Teachers should be provided on the job training on how to conduct practical experiment in classrooms.
f. A wealth of resources for experimentation should be provided.
g. The laboratory should be provided in every Myanmar high school.

Conclusion

In order to fulfill the goal of science education, the teachers must be well prepared in their respective science subjects. They must have a firm understanding of the nature of science and help their students to develop inquiry skills as well as provides scientific and technological knowledge. Students must learn factual information, but, more important, they must discover ideas for themselves through laboratory activities, field studies and library work (Gould, 1984, cited in Collette & Chappetta, 1989).

Science involves highly complex and abstract subject matter that some high school students fail to grasp science concepts without concrete objectives and opportunities for manipulations. The solution of solving above problem is appliance of science laboratory in teaching science because laboratory activities give students concrete experiences in which they can explore new ideas and theories by gathering data and observation. Science laboratory has an important role in learning science. Practical work is more important because of the fact that people learn by imitating and by doing scientific principles and applications. Practical classroom experiments help in boarding pupils experience and develop initiative and cooperation. Science is a laboratory oriented subject because it contains a lot of practical wok to do in teaching and learning process. Science laboratory is a crucial factor in learning and achievement in that subject.

The laboratory activities have had distinctive and central role for science curriculum. The science teachers asserted that many benefits mount up from engaging students in science laboratory activities. So, science laboratory play an important role in science teaching.

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Appendix A

Interview Questions for Science Teachers

စဉ်	မေးခွန်းများ
	Demographic Factor
1.	Gender: Male ☐ Female ☐
2.	How old are you?
	အသက်ကိုပြောပြပါ။
3.	Which certifications did you got?
	ရရှိခဲ့သောဘွဲ့ကို ဖော်ပြပါ။
4.	What is your teaching services?
	စုစုပေါင်း လုပ်သက်ကိုဖော်ပြပါ။
5.	Which subject do you teach at present?
	လက်ရှိသင်ကြားနေသော ဘာသာရပ်ကိုဖော်ပြပါ။
6.	Which grade do you teach at present?
	လက်ရှိသင်ကြားနေသောအတန်းကိုဖော်ပြပါ။
7.	Describe your total teaching periods at present?
	လက်ရှိသင်ကြားနေသော စုစုပေါင်းစာသင်ချိန်ကို ဖော်ပြပါ။
8.	How long is your teaching services as a science teacher?
	သိပ္ပံဘာသာသင်ကြားနေသော စုစုပေါင်း လုပ်သက်ကိုဖော်ပြပါ။
	Teaching Science
1.	Which teaching methods do you always use in teaching science? Explain one of them?
	သိပ္ပံဘာသာရပ် သင်ကြားရာတွင် မည်သည့်သင်နည်းများကို အမြဲတမ်း ထည့်သွင်းအသုံးပြု သင်ကြားသနည်း။ တစ်ခုအကြောင်း ရှင်းပြပါ။
2.	What is your aim of teaching science? Why do you set this aim?
	သိပ္ပံဘာသာရပ်သင်ကြားခြင်းနှင့် ပတ်သက်၍ သင၏ရည်မှန်းချက်ကိုပြောပြပါ။ အဘယ်ကြောင့် ဤရည်မှန်းချက်ကို ချမှတ်ပါသနည်း။
3.	Which difficulties do you always face in teaching science? How do you solve them?
	သိပ္ပံဘာသာရပ်သင်ကြားရာတွင် သင် တွေ့ကြုံရသော အခက်အခဲများကိုဖော်ပြပါ။ ထိုအခက်အခဲများကို သင်မည်ကဲ့သို့ ဖြေရှင်းပါသနည်း။
4.	How do you feel about science teaching?
	သိပ္ပံဘာသာရပ်သင်ကြားခြင်းနှင့် ပတ်သက်၍ သင်မည်ကဲ့သို့ တွေ့ကြုံခံစားရပါသနည်း။
5.	Are you interested in teaching science? Why?
	သိပ္ပံသင်ကြားမှု အပေါ်စိတ်ဝင်စားအမှုရှိပါသလား။အဘယ်ကြောင့် စိတ်ဝင်စားပါသနည်း။
6.	Do you apply science laboratory in teaching science? Why?
	သိပ္ပံဘာသာရပ်သင်ကြားရာတွင် လက်တွေ့ခန်းကို အသုံးချပါသလား။ အဘယ်ကြောင့်လက်တွေ့ခန်းကို အသုံးပြုပါသနည်း။

စဉ	မေးခွန်းများ
	Teaching Science
	Using Science Laboratory
1.	What is your purpose of doing laboratory work in science laboratory? Why do you set this purpose?
	လက်တွေ့ခန်းအတွင်း လက်တွေ့လုပ်ငန်းများဆောင်ရွက်ရခြင်းနှင့် ပတ်သက်၍ သင်၏ရည်ရွယ်ချက်ကိုဖော်ပြပါ။ အဘယ်ကြောင့် ဤရည်ရွယ်ချက်ကို ချမှတ်ပါသနည်း။
2.	Do you think that science laboratory is necessary for teaching science? Why do you think like this?
	သိပ္ပံ သင်ကြားမှုအတွက် သိပ္ပံလက်တွေ့ခန်း လိုအပ်သည်ဟု သင်ထင်မြင်ယူဆပါသလား။ အဘယ်ကြောင့် ဤကဲ့သို့ထင်မြင်ယူဆပါသနည်း။
3.	How many periods per week do you teach in science laboratory? How long take a period?
	သိပ္ပံလက်တွေ့ခန်း အတွင်း တစ်ပတ်လျှင် အချိန်မည်မျှ သင် ဝင်ရောက်သင်ကြားပါသနည်း။ စာသင်ချိန်တစ်ချိန်၏ ကြာချိန်ကိုဖော်ပြပါ။
4.	Is there laboratory assistant to help you in the laboratory?
	သိပ္ပံလက်တွေ့ခန်း အကူရှိပါသလား။ သူ/သူမက သင်ကိုမည်သို့ ကူညီဆောင်ရွက်ပေးသနည်း။
5.	Before lesson or after lesson, when do you use science laboratory? Why do you use like this?
	သင်ခန်းစာ သင်ပြီးနောက် လက်တွေ့ခန်းကိုအသုံးပြုပါသလား။ သင်ခန်းစာမစတင်မီ လက်တွေ့ခန်းကိုအသုံးပြုပါသလား။ အဘယ်ကြောင့် ဤ ကဲ့သို့ အသုံးပြုပါသနည်း။
6.	Which methods do you use in teaching science in the laboratory? Why do you use them?
	သိပ္ပံလက်တွေ့ခန်းတွင် သိပ္ပံ သင်ကြားသောအခါ မည်သည့်သင်နည်းများကို ထည့်သွင်းအသုံးပြုသင်ကြားပါသနည်း။ အဘယ်ကြောင့်နည်း။
	Implementation of Laboratory Work
1.	How do you implement laboratory work?
	သိပ္ပံလက်တွေ့ခန်းလုပ်ငန်းများကို သင်မည်ကဲ့သို့ အကောင်အထည်ဖော်ဆောင်ရွက်ပါသနည်း။
2.	How do you determine the laboratory procedure?
	သိပ္ပံလက်တွေ့ခန်း လုပ်ငန်းအစီအစဉ်များကို သင်မည်ကဲ့သို့ ဆုံးဖြတ်ဆောင်ရွက်ပါသနည်း။
3.	How do you assess laboratory work?
	သိပ္ပံလက်တွေ့ခန်းလုပ်ငန်းများကို သင်မည်ကဲ့သို့ အကဲဖြတ်ပါသနည်း။
4.	Which one do you favour: individual laboratory work or group work? Why do you prefer this?
	တစ်ဦးချင်းဆောင်ရွက်ရသော သိပ္ပံလက်တွေ့ခန်းလုပ်ငန်းနှင့် အုပ်စုဖွဲ့လုပ်ဆောင်ရသော လုပ်ငန်းတွင် မည်သည်ကိုအလေးပေးနှစ်သက် ဆောင်ရွက်ပါသနည်း။ အဘယ့်ကြောင့်နည်း။
5.	Which approaches do you use in teaching laboratory work? How do you apply laboratory manual?
	သိပ္ပံလက်တွေ့ခန်းလုပ်ငန်းများ သင်ကြားမှုဆောင်ရွက်ရာတွင် မည်သည့်ချဉ်းကပ်နည်းများကို အသုံးပြုပါသနည်း။ လက်တွေ့ခန်း အသုံးပြုမှုလက်စွဲ စာအုပ်ကို သင်မည်ကဲ့သို့ အသုံးချပါသနည်း။

စဉ	မေးခွန်းများ
6.	Which problem do you face during implementation of laboratory work?
	သိပ္ပံလက်တွေ့ခန်းလုပ်ငန်း အကောင်အထည်ဖော်ဆောင်ရွက်ရာတွင် သင်တွေ့ကြုံရသော အခက်အခဲပြဿနာများကိုဖော်ပြပါ။
	Interest in Doing Practical Experiment
1.	Do you think that teaching science without practical experiment is not interesting? Why do you think like this?
	သိပ္ပံလက်တွေ့စမ်းသပ်ချက်များ မပါရှိပဲ သိပ္ပံသင်ကြားခြင်း သည် စိတ်ဝင်စားဖွယ်ကောင်းပါသလား။ သင်အဘယ်ကြောင့် ဤကဲ့သို့ တွေးထင်ပါသနည်း။
2.	While doing practical experiment, do you prefer teacher-led experiment or student-led experiment? Why?
	လက်တွေ့လုပ်ငန်းဆောင်ရွက် သောအခါ ဆရာဦးဆောင်သော လက်တွေ့စမ်းသပ်ချက် နှင့် တပည့်ဦးဆောင်သော လက်တွေ့စမ်းသပ်ချက် တို့တွင် မည်သည်စမ်းသပ်ချက်ကို သင်နှစ်သက်ပါသနည်း။
3.	Do you think that practical experiment is suitable or not with students' learning? How and why do you perceive like this?
	လက်တွေ့စမ်းသပ်ချက်များသည် ကျောင်းသားများ၏ သင်ယူမှုနှင့် သင့်တော်မှုရှိသည်ဟု ထင်ပါသလား။ သင်သည် အဘယ်ကြောင့် ဤကဲ့သို့ထင်မြင်ယူဆပါသနည်း။ မည်ကဲ့သို့ သင့်တော်မှုရှိပါသနည်း။
4.	How do you think that there is any relationship between the practical experiment and students' learning theoretical lessons?
	လက်တွေ့စမ်းသပ်ချက်များ နှင့် ကျောင်းသားတို့၏သဘောတရားဆန်သော သင်ခန်းစာများနှင့်ပတ်သက်သည့် သင်ယူမှုကြား ဆက်စပ်မှုရှိခြင်းကို သင်မည်ကဲ့သို့ ထင်မြင်ယူဆပါသနည်း။
5.	Is the laboratory material and equipment suitable and enough for the students? If not, how do you implement practical experiment?
	လက်တွေ့ခန်းပစ္စည်းကိရိယာများ သည် ကျောင်းသားများအတွက် သင့်တော်လုံလောက်မှု ရှိပါသလား။ သင့်တော်လုံလောက်မှု မရှိခဲ့သော် လက်တွေ့စမ်းသပ်ချက်များကို သင်မည်ကဲ့သို့ အကောင်အထည်ဖော်ဆောင်ရွက်ပါမည်နည်း။
6.	What is the difference of students' learning between conventional teaching and doing science experiment? How do you think about this difference?
	လက်တွေ့စမ်းသပ်ချက် များဆောင်ရွက်ချိန်နှင့် သာမန်စာသင်ချိန်ကြား ကျောင်းသားများ၏ သင်ယူတွင် မည်သည့်ခြားနားချက်ရှိပါသနည်း။ ထိုခြားနားချက်ကိုသင်မည်ကဲ့သို့ ထင်မြင်ယူဆပါသနည်း။

စဉ်	မေးခွန်းများ
	Perception toward Teaching Science in the Laboratory
1.	How do you believe that science laboratory has the impact on students' learning?
	သိပ္ပံလက်တွေ့ခန်းသည် ကျောင်းသားများ၏ သင်ယူမှုအပေါ် သက်ရောက်မှုရှိသည်ကို သင်မည်ကဲ့သို့ ယုံကြည်လက်ခံပါသနည်း။
2.	Do you think that laboratory work are enough to concretise abstract knowledge for students? Why do you think that?
	လက်တွေ့လုပ်ငန်းများသည် ကျောင်းသားများအတွက် လက်ဆုပ်လက်ကိုင်မပြနိုင်သော အသိပညာများကို လက်ဆုပ်လက်ကိုင် ပြနိုင်သော အသိပညာအဖြစ်သို့ ပြောင်းလဲပြုလုပ်နိုင်ရန်အတွက် သင့်တော်မှုရှိပါသလား။ သင်မည်ကဲ့သို့ထင်မြင်ယူဆပါသနည်း။
3.	Do you believe that students could apply knowledge gained through learning in science laboratory in their daily life? How can they apply? Why?
	လက်တွေ့ခန်းမှရသောအသိပညာများကို ကျောင်းသားများ၏ လက်တွေ့ဘဝတွင် အသုံးချနိုင်မည်ဟု ယုံကြည်ပါသလား။ ကျောင်းသားများသည် ထိုအသိပညာများကို မည်ကဲ့သို့ အသုံးချနိုင်သနည်း။ အဘယ်ကြောင်နည်း။
4.	Do teaching science in the laboratory progress students' learning and active participation? How do they progress?
	လက်တွေ့ခန်းအတွင်း သိပ္ပံသင်ကြားခြင်းသည် ကျောင်းသားများ၏ သင်ယူမှု နှင့် တက်ကြွစွာပူးပေါင်းဆောင်ရွက်တတ်မှုကို တိုးတက်စေပါသလား။ ကျောင်းသားများသည်မည်ကဲ့သို့ တိုးတက်ပြောင်းလဲလာပါသနည်း။ အဘယ်ကြောင့်နည်း။
5.	How do you feel about teaching science in the science laboratory yourself?
	လက်တွေ့ခန်းအတွင်း သိပ္ပံသင်ကြားခြင်းအပေါ် သင်ကိုယ်တိုင် မည်ကဲ့သို့တွေးမြင်ခံစားပါသနည်း။
6.	How do your headmaster/headmistress support for your science laboratory? Do you attend laboratory course? How do this course support for your teaching?
	လက်တွေ့ခန်းအတွက် သင်၏ကျောင်းအုပ်ကြီးမှ မည်ကဲ့သို့ကူညီထောက်ပံ့မှုများ ပြုလုပ်ပေးပါသနည်း။ လက်တွေ့ခန်းသင်တန်းတက်ရောက်ဖူးပါသလား။ ထိုသင်တန်းက သင်ကြားမှုအတွက် မည်မျှအထောက်အကူပြုပါသနည်း။

Appendix B 1

Observation (I)

School ----------

Checklists for the Physical Appearance of Science Laboratory

No	Indicator / Statement	Poor	Fair	Good
	Organization			
1.	Ventilation System			
2.	Waste Disposal			
3.	Clean			
4.	Lighting			
5.	Water Supply			
6.	Usage of Basin			
7.	Structures of Tables			
8.	Structures of Shelves			
	Appliance of Teaching Aids			
9.	Uses of Charts			
10.	Uses of Models			
11.	Periodic Table			
12.	Laboratory Safety Rules			
	Maintainance			
13.	Storage of Chemicals			
14.	Storage of Materials			
15.	First-aid box			
16.	Laboratory Manual			
17.	Stock Register			
18.	Instructional Card			
19.	Pupils' Practical Notebook			
20.	Record of Doing Practical Work			

Appendix B2

Observation (II)

Performance during Laboratory Work

1. Subject ----------
2. Topic ----------
3. Period ----------
4. No of students ----------
5. Experiment ----------
6. Apparatus ----------
7. Materials ----------
8. Aim ----------
9. Procedure ----------

   ----
10. Techniques used ----------
11. Methods applied ----------

If the teacher used Laboratory method or Student-led demonstration

	Teacher performance	**Yes**	**No**	**Students performance**	**Yes**	**No**
1.	Lesson introduction					
	Asking Questions			Answer questions		
	Discussion			Active discussion		
	Grouping students			Actively participation		
	Giving the required apparatus			Carefully and systematically use		
2.	**Predicting and overview of activity**					
	Arousing investigative questions			Describe investigative questions		
	Designing experiment			Carefully note taking		
	Laboratory safety instruction			Carefully pay attention to teacher		
	Explaining instructional procedure			Carefully listening and asking questions about unclear facts		
3.	**Performing experiment**					
	Teacher monitor group as they work on the laboratory			Systematically, actively and individually perform experiment		
	Helping students with difficulties in doing experiment			Know how to use apparatus & Asking teachers for their difficulties		
	Telling students to collect the data from experiment			Collecting data from careful observation		
	Discussion with students			Discussion with teacher or peers		
4.	**Closure**					
	Summarize, transfer and relate to real life			Reporting their observation and summarization		
	Evaluation of students' work			Answer questions		

If the teacher used teacher-led demonstration

	Teacher performance	Yes	No	Students performance	Yes	No
1.	**Purposing**					
	The class (or) and teacher decides an activity that involves demonstration			Decides an activity that involves demonstration		
	Asking questions			Answer questions		
	Discussion			Discussion		
2.	**Planning**					
	Grouping students			Actively participation		
	Designing experiment			Carefully pay attention		
	Laboratory safety instruction			Carefully note taking, and listening		
3.	**Proper demonstration**					
	Teach the theory of concepts before demonstration			Asking investigation questions and carefully pay attention		
4.	**Executing**					
	Self-preparation			Self-preparation		
	Right explanation			Right explanation		
	Starting experiments			Starting experiments		
	Handling instrument			Handling instrument		
	Explaining observations			Explaining observations		
				Writing report		
5.	**Evaluation**					
	Asking questions			Answering questions		

Appendix C

Teachers' Responses to Interviews

Q : What is your aim of teaching science?
P1: "To get knowledge and got distinctions with high marks."
P2: "To complete a course outstandingly."
P3: "To understand the lessons clearly."

Q : How do you solve difficulties facing in teaching science?
P1: "I searched the photos and videos relevant to the lessons and show them to students."
P2: "Sometimes, I showed the pictures that are downloaded from internet."
P3: "I download the pictures from the internet. When I show these photos, students understand lessons."

Q : What is your purpose of doing laboratory work?
P1: "I aims students to learn lesson by doing experiments rather than by heart."
P2: "Students will make reasoning for everything."
P3: "Students will clearly and easily study the lessons."

Q : How many periods per week or month do you always teach laboratory work?
P1: "Relating to the lesson." "Can't tell the periods explicitly."
P2: "I have to favour the normal teaching periods."
P3: "The laboratory work cannot be done for every lesson." "Can't tell the exact period."

Q : Why do you use science laboratory after lesson?
P1: "Because students have known terminology, they can guess what can happen."
P2: "Before the lesson, students do not know theory."
P3: "After the lesson, they can verify theory."

Q : Why do you use science laboratory before lesson?
P1: "Since students firstly get the concrete experience, they are more interested. Can get more knowledge in giving lecture.
P2: "To improve their understanding"

Q : How do you assess laboratory work?
P1: "I assess students' understanding by asking questions"
P2: "I give A, B grade on practical work book."
P3: "The practical marks are not needed for final results."

Q : Which one do you favour: individual lab work or group lab work?
P1: "Group works can emerge good social interaction among students."
P2: "Group work is better because students give their opinions to each other."
P3: "Time is not enough to do individual laboratory work."

Q : Do you think that practical experiment is suitable with students' learning?
P1: "Practical experiments are linked to the lessons." "Because of them, students can verify that theory is true."
P2: "Without practical experiment, teaching science is like story telling."
P3: "Students answer the questions without forgetting unimportant facts."

Q : How do you think that there is any relationship between the practical experiment and students' learning theoretical lessons?
P1: "Yes, they are related. If they see experiments, they understand the refraction of light and law of refraction."
P2: "Theory and practical experiments are related. So, experiment can identify that theory is true."
P3: "After explanation of theory, I taught how to apply it in practical. Students are more likely to understand the theory."

Q : How do you believe that science laboratory has the impact on students' learning?
P1: "It is the most believable fact. Science lab effects on students' learning."
P2: "Since students directly see the experiments, they are easy to recognize the lessons."
P3: "They remember the lessons. We should do laboratory work more than conventional teaching.

Q : Do you believe that students could apply knowledge gained through learning in science laboratory in their daily life? How they can apply? Why?
P1: "Some can be applied for the next level or grade."
P2: "If students can apply knowledge, they may create new things."
P3: "Through finding the result and solving problems in schools, students get process skills, and ways to solve their real life problems.