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Joanna Marie A. de Borja, Arlyne C. Marasigan, Ph.D.

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Status of Science Laboratory in a Public Junior High School

Joanna Marie A. de Borja
https://orcid.org/0000-0002-7684-160
deborja.jma@pnu.edu.ph
PhD Science Education Student, Philippine Normal University - Manila, Philippines

Arlyne C. Marasigan, Ph.D.
https://orcid.org/0000-0003-2362-7634
marasigan.ac@pnu.edu.ph
CGSTER Faculty, Philippine Normal University - Manila, Philippines

Abstract

The laboratory is the heart of science in which the individual could put theory into practice. School laboratory is essential to the holistic development of a learner as it involves multiple tasks to understand complex concepts. However, students were not able to perform laboratory experiments and activities as there are issues regarding the adequacy of laboratory materials and apparatuses, class size, time duration of an experiment, available laboratory room, and safety. To address the issues, teachers provide the materials for the students to perform the experiment and/or download YouTube videos of experiments or activities that show the science concepts being discussed. The Department of Education is fully aware of this current condition thus, laboratory activities need not utilize expensive apparatuses and materials. Nevertheless, science and technology in the high school level will not advance unless appropriate materials and laboratory facilities will be provided. Based on this study, teachers suggested that the government should support the funding of Science laboratories and at the same time decrease class size for the students to reach optimum development of learning as they believe that Science experiments will help students to have better retention and appreciation of the science concepts.

Keywords: education, Science laboratory, K to 12 Science curriculum, case study, Philippines

1. Introduction

1.1 Background

According to the United Nation Sustainable Development Goals (SDG), achieving quality education will serve a strong foundation for sustainable development. Education is very significant in achieving different SDGs as the cycle of poverty can break. Likewise, it helps lessen inequalities and therefore reach gender equality and people live more healthy and better sustainable lives as they are properly educated. Improving the quality of life can help prepare locals with the necessary tools to develop solutions to the world's greatest problems. Thus, reaching the goal of inclusive and quality education reaffirms the belief that education is one of the most powerful and proven ways for all known sustainable development.

To achieve such a goal, quality education to be provided to the children of impoverished families, educational scholarships, teacher training workshops, school building, and improvement of water and electricity access to schools. However, many countries still lack quality education due to the inadequate number of trained teachers, poor conditions of schools, and equity issues.

K to 12 Curriculum

Meanwhile, K to 12 curriculum was implemented in the Philippines in 2012 due to the following reasons: a) the only country in Asia with 10 years of basic education, poor quality of education, too many non-practical subjects, students are not prepared for college education and very young for labor force, and finally no global recognition (K12Philippines, November 2, 2015). One of the key features of the K to 12 curricula is the spiral progression approach which directly affects the scope and sequence of the Science curriculum. Spiral progression is associated with discovery learning theory of Bruner which states that by building on their current knowledge students can learn best (Corpuz, 2014). Likewise, students will build fresh new concepts by reviewing core ideas and associating fresh knowledge. Thus, different from the old curriculum, the K to 12 curriculum, on the other hand, is decongested. It has its concentration on understanding for mastery and it assures smooth shifting between grade levels and the relationship of competencies through spiral progression (Southeast Asian Ministers of Education Organization, Regional Center for Educational Innovation and Technology [SEAMEO INNOTECH], 2012). The curriculum comparison study of the University of Melbourne (2011) spiral approach prevents the learning gap in stages of education. It promotes connection and consistency avoiding compartmentalization. However, Snider (2004) mentioned that there is a limitation in the spiral approach that can be seen in the variability of rate for introducing new knowledge. The majority of

topics are discussed briefly, which in turn decreases the mastery of the subject matter. Likewise, spiral design shifting on the next topic method resulted in a less priority on the previous concepts until they are discussed in the next year due to a lesser number of time for review. In the study of Resurreccion and Adanza (2015), other countries are also implementing the spiral progression approach in their educational system which professed that the said approach does not apply to the needs of their learners.

Aside from the spiral progression, changes in the number of minutes allotted for Science subjects decreased from 360 minutes to 240 minutes in a week. Thus, the two hours in the Science schedule which is usually spent on laboratory experiments were limited to only one hour. This has significantly changed the pedagogy of Science teachers especially when it comes to hands-on activities.

Similarly, there were also changes in the grading system when K to 12 curriculum. As stated in DepEd order no. 8, s. 2015 dated April 1, 2015, DepEd will follow a new grading system for the K-12 Basic Education Program which took effect for all grade levels in public schools from elementary to Senior High School. The grading system is comprised of three components - written works, performance task, and quarterly assessment.

Teaching-Learning Science

The aims of Science education in the Philippines is to develop scientific literacy among learners that will prepare them to be informed and participative citizens. These are citizens who can make judgments and decisions on applications of scientific knowledge that may have social, health, or environmental impacts as stipulated in the K to 12 Curriculum Guide Science (2012, January 31).

Science curriculum is crucial in the integration of science and technology in everyday life - social, economic, personal, and ethical aspects of life. Similarly, it makes learners competent to the world of work due to its direct impact on the development of scientifically, technologically, and environmentally literate and productive members of society.

This curriculum is divided into two: content and processes. The content will guide the students in applying science process skills since these are best learned in context. Thus, students will become active learners utilizing varied hands-on, minds-on, and hearts-on activities.

As a whole, the K to 12 science curriculum is learner-centered and inquiry-based, which focuses on the use of evidence in constructing explanations. The integration across science topics and other disciplines will lead to a meaningful understanding of concepts and its application to real-life situations (K to 12 Curriculum Guide Science, 2012, January 31).

Science Laboratory

With the guiding principle of the Science curriculum, Science experiments or hands-on activities play an important role to achieve its goals. Science laboratory is said to be the heart of Science in which an individual could put theory into practice. Duit and Tesch (2010) in their study said that the experiment plays a truly significant role in science instruction as they believed that hands-on needs to include minds-on. That means, that not all experiments including those that are beautifully designed result in the outcomes expected, they need to be staged adequately in such a way that hands-on and minds-on occur. Millar (1987) in his study also emphasized how the experiment plays a central role in Science education. Science classes should happen in the laboratory and involve students either in carrying out practical tasks for themselves or observing their performance by a teacher. Moreover, the American Chemical Society (2019) claimed that hands-on laboratory science experiences are very important to the learning processes across all areas of study. Also, the society said that research has shown that students who were exposed to well-designed laboratory experiences develop problem-solving and critical-thinking skills, as well as gain exposure to reactions, materials, and equipment in a lab setting. The society also stated how learning advances due to hands-on experiences designed and guided by qualified educators.

During hands-on chemistry activities, students directly and safely investigate chemical properties and reactions, utilizing laboratory apparatus and instruments which are essential for learning chemistry and improving science literacy. On the other hand, web-based and computer-simulated activities per se may help increase student exposure to chemistry, reduce costs, and eliminate hazardous waste and safety concerns; however, these tools cannot be considered as similar replacements for hands-on laboratory experiences.

In the study of Ornstein (2006) which the results partially supported the hypothesis that students have more positive attitudes toward science when teachers regularly conduct hands-on laboratory activities and when students more frequently experience higher levels of experimentation or inquiry. Moreover, analysis of individual student data showed more positive attitudes in hands-on classrooms on all three factors at the .01 level of confidence while data based on class averages offered opposing differences. More challenging, open-ended experimentation and inquiry experiences produced more positive student attitudes. This was especially true when students were provided frequent opportunities to generate independent hypotheses and draw their conclusions.

However, in the Philippines, there is a lesser focus when it comes to Science laboratory most especially in public schools. Issues arose as an inadequate number of laboratory rooms as against the number of students, lack

of laboratory materials, enough training of Science teachers in this venture, and most especially, safety readiness and resilience of schools during laboratory experiments accidents.

1.2. Framework of the Study

This study evolves in Kolb's experiential learning style theory which is typically represented by a four-stage learning cycle in which the learner 'touches all the bases': The first stage (concrete experience) involves a new experience or situation being encountered by learners or reinterpretation of existing experience. The learners will then check inconsistencies between experiences and understanding or reflective observation of the new experience. After reflection, learners will construct new ideas or will modify an existing abstract concept that the learner has learned from experience. Finally, the learners apply the ideas to the world around them to see what happens of active experimentation.

This theory indicates the importance of hands-on activities that directly involve experiences of learners such as experiments to help them build new ideas. This also proves that through these kinds of activities learners will be able to verify existing knowledge such as Science concepts and contents which will, therefore, lead to applications of knowledge to real-life situations thus, achieving the goals of the K to 12 curriculum.

1.3 Statement of the Problem

This research aimed to answer the following questions:

1. What is the status of the science laboratory?
2. How do the facilities address the prescribed laboratory activities?
3. What are the challenges met and recommendations by Science teachers with regards K-12 status of science laboratory?

2. Methodology

2.1 Research Design

This research utilized the case study research design. Yin (2003) defines case study research as an inquiry that ‘‘investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not evident; and in which multiple sources of evidence are used’’ (pp. 13–14). This research design was used in investigating the current condition of the laboratory in one of the public schools in Calamba City. Documents such as number of Science teachers, number of acquired laboratory materials, laboratory room and usage, K to 12 curriculum guide for Science, class size, and class schedules were checked during the conduct of the study. Likewise, semi-structured interviews were conducted with the Science teachers of the said school.

Table 1 shows the profile of teacher-respondents. Since the study is about the status of Science laboratories, the respondents are Science teachers of one public junior high school in Calamba City for the academic year 2018-2019.

Table 1: Profile of Teacher-Respondents

Teacher	Gender	Teaching Experience	Teaching Load
A	Female	4 years	Grade 7 Science
B	Female	5 years	Grade 7 Science
C	Female	13 years	Grade 8 Science
D	Female	28 years	Grade 8 Science
E	Female	18 years	Grade 9 Science
F	Female	6 years	Grade 9 Science
G	Female	14 years	Grade 10 Science
H	Male	9 years	Grade 10 Science

There are two representatives per grade level. The respondents are diverse when it comes to the number of teaching experiences. The majority of the teachers have 4 to 6 years of teaching experience while there are teachers who have 13 to 14 years of experience. Lastly, some teachers have 18 and 28 years of teaching experience who are already considered as experienced teachers. The majority of these teachers only have one teaching preparation and the rest are two teaching preparations. The other teaching assignment was not mentioned in this study.

To collect pertinent information for this research, the researchers carefully organized in a way appropriate for responding to the research questions. The researchers first conduct document analyses for the existing activities through the learning materials of the K to 12 Science curriculum given by DepEd. Likewise, document analyses were also done to check the existing laboratory materials, laboratory room, Science laboratory schedule, number of teaching load, and number of students per section. Finally, the researcher conducted a semi-structured interview with the Science teachers to check the challenges and how laboratory activities are done with the use of existing laboratory materials and equipment. Science teachers are interviewed one-by-one. The results of the interview were interpreted through a thematic approach.

2.2 Results and Discussion

The following are the results of the document analyses and interview with the Science teachers that answer the problems of the study.

Status of the Science Laboratory

Table 2 shows the total population of students in junior high school in the school for the academic year 2018-2019. There are a total of 1608 junior high school students. Each grade level has a Special Education (SPED) section which also comprised of the least number of students.

There is an unequal number of students per section in each grade level for the regular students. The minimum number of students in one section is 34 while the maximum is 54. Grade 7 level has the most number of sections while grade 10 has the least. The school has a significant increase in the number of students. There are minimal cases of drop-outs. Given these digits in the population of students, there is only one laboratory room shared by all classes for the school which led to laboratory activities to be done outside the laboratory room considering the number of sections per grade level and worst some laboratory activities were not performed due to lack of available laboratory to perform experiments. There is only one laboratory for all which means that there is no separated laboratory room for each Science discipline such as Biology, Chemistry, and Physics.

Table 2: Class Size per Grade Level for AY 2018-2019

Grade 7	Grade 8	Grade 9	Grade 10
53	46	47	34
51	50	54	48
50	46	52	50
52	51	51	*8**
54	49	52	45
46	51	51	47
*13**	52	*10**	49
52	51	39	—
46	40	—	—
48	*11**	—	—
51	—-	—-	—-
50	—-	—	—
553	**436**	**346**	**273**

**SPED Section* *Total: 1608*

Table 3 shows the available furniture inside the Science laboratory room. Conflict in the schedule with regards to the usage of the laboratory room is very high which oftentimes leads the teachers to just download YouTube videos that will show the supposed laboratory activity for the students.

Table 3. Available furnitures in the laboratory

Furniture	Frequency
demonstration table	1
display cabinet	3
science laboratory table	9
high chairs	40

Likewise, there is a limited number of laboratory tables and high chairs against the class size. There are only 40 high chairs available inside the laboratory while there are classes that are composed of more than 40 students. Therefore, according to the teachers, students who cannot be accommodated by the number of chairs are asked to stand or share with other students during the entire duration of experiments.

Table 4 which illustrates the available equipment inside the laboratory room indicates very limited equipment that can be used during science laboratory activities, especially for Physical Sciences. As a result, there will be limited laboratory experiments that can be performed by the students which may be essential in understanding concepts in Science. Likewise, according to Science teachers who were interviewed, the students are grouped into five per class which are composed of 9-11 members. This number of members in a group directly affects the performance of the students during laboratory activities as science process skills cannot be observed in each member. In an instance, there is a great number of available test tubes but there is only 1 test tube holder. This inadequacy of laboratory equipment will result in unsafe experiments especially if it involves heating. Likewise, there are problems concerning water supply inside the laboratory room due to unfixed faucets and tubing. Water is very essential in most experiments, sanitation, and emergency cases.

Table 4. Available Equipments

Equipments (Physical Science)	Frequency
alcohol lamp	5
equal arm balance	2
double beam balance	2
microscope	7
dissecting microscope	9
beaker big	6
beaker small	3
erlenmeyer flask	10
graduated cylinder big	7
graduated cylinder small	1
test tube	41
test tube rack	10
test tube holder	1
tuning fork	24
wire gauze	2
mortar and pestle	7

(Biological Science)	Frequency
frog dissection	1
animal cell division (mitosis)	1
animal cell division (meiosis)	6
plant mitosis	4
plant cell division (meiosis)	2
mitosis activity set (enlarge)	2
torso human figure	1
circulatory system	1
digestive system	1
nervous system	1
reproductive system (Male)	1
reproductive system (female)	1
human heart	1
human brain	1
human skeletal	1
urinary system	1

On the other hand, equipment for Biological Sciences are purely for demonstration purposes only. When equipment in this area were checked by the researchers, some parts were already missing such as in the reproductive systems of the body.

Moreover, when the researcher checked the accuracy of measurement of laboratory equipment such as microscopes and beam balance, there were inconsistencies in measurement which will result in failed experiments or

high percentage errors in measurements. According to the Science coordinator, the school can't pay for the calibration of laboratory equipment or even hire laboratory assistants or personnel to handle such issues. Teachers have limited training when it comes to proper handling of equipment especially chemicals though in Table 4, the list only include equipment. There are no acquired chemicals and other materials for experiments. According to the teacher-respondents, since the school is an integrated school (integrated schools are schools with senior high school), teachers are asking for some supply from the laboratory supply of senior high school. This system will just limit each grade level to perform laboratory experiments.

Addressing the prescribed laboratory activities

The laboratory is a room or a building specially built for teaching by demonstration or hands and minds-on experience of what learners have learned through classroom discussions. This will help further verify the knowledge that has been acquired to practical realities which the majority of teachers agreed when asked about the importance of laboratory experiments in the K to 12 Science curriculum. According to the teachers, students have more appreciation of the lessons when students are exposed to laboratory activities. They tend to remember more the lessons when students were able to perform experiments related to the lesson being discussed. Likewise, teachers believed that students have more retention when exposed to laboratory experiments since they underwent rigorous scientific process skills.

However, with the current condition of the school when it comes to the availability of laboratory room and equipment, teachers are challenged on how laboratory experiments can be performed by the students. When K to 12 curriculum was implemented, DepEd already provided the learning materials for all subjects. The researchers then checked the learning materials for Science specifically on the part of the learning activities since according to Science teachers, all laboratory experiments and activities are recorded as performance tasks of students. The researchers found out that most of the activities do not require prestigious equipment. Readily available equipment or improvised materials are just needed for the activities given in the learning materials. This strongly indicates that DepEd is fully aware of the current condition of the laboratory room and equipment in public schools. However, DepEd aims to develop scientific literacy through strong science process skills among students. This will not progress if there is lesser support when it comes to advanced experiments and activities. American Chemical Society (2019) mentioned that society strongly believed that there is no equivalent substitute for hands-on activities where materials and equipment are used safely and student experiences are well-guided. Likewise, Ornstein (2006) concluded that students have more positive attitudes toward science when teachers regularly emphasize hands-on laboratory activities and when students more frequently experience higher levels of experimentation or inquiry.

Even though DepEd only requires improvised or readily available materials, teachers still have problems when it comes to giving the activities to students. Due to the inadequate equipment in the laboratory and available laboratory room, teachers do not perform all the prescribed learning activities given by DepEd. In some cases, teachers asked students to bring the materials or equipment needed in the experiment but forcing students to bring is prohibited so, in the end, teachers are still the ones who provide the materials for the experiment. Also, teachers also do not let students perform the experiments or activities due to time constraints. This is because the K to 12 program decreased the allotted time for Science to 4 hours a week which in turn does not support most experiments. According to teachers, most of the activities given by DepEd are time-consuming. With these, teachers use some modifications in the experiments or activities prepared by DepEd to address the issues. Moreover, since the school was provided with televisions in all classrooms, the majority of the teachers just download YouTube videos of experiments or activities to show the concept or content being discussed. Teachers will just provide guide questions for students to answer after watching the videos. This way of addressing the problem hinders the learners to develop science process skills and improve scientific literacy among them. Kolb (1974) in his theory explained the importance of the four stages of learning - concrete experience, reflective observation, abstract conceptualization, and active experimentation. Duit and Tesch (2010) in their study said that hands-on needs to include minds-on. That means, diligently and beautifully designed experiments do not necessarily result in the outcomes expected – they need to be staged adequately in such a way that hands & minds-on actually may occur.

Challenges met and recommendations by Science teachers with regards K-12 status of science laboratory

As mentioned in the above discussions, the main problem of Science teachers is the status of Science laboratory - the inadequacy of equipment and available laboratory rooms. It is a consensus to all Science teachers that laboratory experiment is vital for the students to understand Science concepts more since theory could put into practice. Similarly, teachers believed that better appreciation and retention are developed whenever students are exposed to laboratory works. However, existing problems in the Science laboratory directly hinder the teachers to provide laboratory experiments for students. The existing number of furniture such as chairs inside the laboratory does not coincide with the number of students in a class which resulted in some students standing during the entire laboratory hours. In addition, the number of students in a class as against the number of available equipment and mate-

rials resulted to have lesser number of groups in a class (averaging from 8 to 10 members in a group). This is another problem for teachers during the actual laboratory experiments.

On the other hand, even if DepEd only provide activities that do not need prestigious or expensive laboratory equipment and materials and only need readily available materials, teachers are still the one buying for incomplete materials. Some teachers said that sometimes students are assigned to bring the materials, however, students cannot be forced to buy materials especially those who are not capable. Likewise, if teachers cannot also provide the materials, downloading videos from YouTube is one way to let students develop critical thinking by giving guide questions. Students will watch videos of the supposed-to-be experiment that students should perform then answer the guide questions that are written in the learning materials of DepEd. However, the best way for the students to appreciate Science concepts and have better retention of the lessons, practical applications are still the best. The National Science Education Standards (NRC, 1996) states that inquiry in general and inquiry in the context of practical work in science education is central to the achievement of scientific literacy and quality education. Thus, Science teachers are asking if the government can give more budget for Science laboratories since the thrust of the K to 12 Science program geared towards scientific literacy and quality education. Some respondents said that the school may ask donations from stakeholders.

On the other hand, the absence of a laboratory assistant also adds tasks for Science teachers since there is nobody to be assigned in organizing materials which were strongly emphasized by some teachers. But due to the bulk work of these teachers, organizing equipment in the laboratory is not the focus. Moreover, the school laboratory also has a problem when it comes to safety and procedures. Most of the teachers said that there should be teachers' training when it comes to proper handling and experimentation. When K to 12 curriculum was implemented which followed the spiral progression approach, issues about the field of specialization were raised. Most of the teacher-respondents said that if you are a Biology major, it would be hard to give experiments in Physics and Chemistry which is true with other teachers with different Science specialization. Likewise, the number of hours for Sciences is only given 4 hours a week. Time constraint is always an issue in performing laboratory works from pre-lab, lab proper, down to post-lab. These prevailing issues should be addressed by DepEd.

3. Conclusions

Based on the salient findings, the researchers, therefore, conclude that the status of Science laboratory in a junior public high school in Calamba City needs immediate action as a school laboratory is essential to the holistic development of a learner as it involves multiple tasks to understand complex concepts. To achieve these, quality instruction should be given to students including Science laboratory as it is said to have distinctive and central role in the Science curriculum and Science educators have suggested that many benefits accrue students in the Science laboratory activities [Hofstein and Lunetta, 2004; Tobin 1990; Hodson, 1993; Lazarowitz and Tamir, 1994; Garnett et al., 1995; 26 in Hamidu, Ibrahim, & Mohammed, (2014)]. Inadequate laboratory equipment and materials and mismatch number of laboratory rooms and its furniture against a big population of students hinder the teachers to let students perform Science experiments. Absence of laboratory assistant, safety and procedures inside a laboratory, training of teachers in Science experiments and proper handling of equipment and materials, and maintenance including equipment calibration contribute to the current condition of Science laboratory. Lack of budget of the Philippine government to this kind of venture makes the whole system suffer - teachers, students, curriculum, and quality education. Changes made in the K to 12 curriculum such as spiral progression, grading system, and a number of hours allotted to Science subjects also add up to the challenges met by teachers with regards Science laboratory.

4. Recommendations

From the conclusions, the following recommendations were drawn:

To improve the current status of Science laboratory government should provide resources and revisit the K to 12 curriculum including learning materials that will enhance the use of laboratory methods and improve the quality of science instruction. Check also the safety and procedures inside the laboratory to prevent future emergencies. Science teachers should also be provided with training in the proper handling of equipment and materials. Likewise, training of teachers concerning experiments that are not in their field of specialization should also be provided. The additional funds should be allotted for the maintenance and calibration of equipment in the laboratory to prevent errors during experimentation.

The school head with the assistance of Science teachers should conduct action research that includes needs assessment in Science laboratory that will be used to prepare a 3-year developmental plan in the Science laboratory so that there will be the gradual acquisition of materials in the laboratory. Observation during laboratory experiments and activities should be done as well. With this, the school may be able to check the proportion of laboratory equipment and materials versus the number of students in a class. Likewise, proper scheduling with regard to the use of Science laboratory will also be maximized. The results of this research should be forwarded to the DepEd Science supervisor to help in improving the current status of the Science laboratory.

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