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Implementation and Constraints of Science Practical Work in High School(Case Study of High School Science Teachers in Garut Regency)

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ABTSRACT

Practical work plays very important roles in science education and therefore schools should pay attention on the implementation of it. Unfortunately, many say that laboratory experiment is not a learning priority in schools in Indonesia. This study aims to verify the statement, by collecting the quantitative data of the number of science practical works done by high school teachers on a fiscal year at least in the region where the research was conducted as well as to seek ways to improve the quality of laboratory activities at schools through identification number of practical works that conducted compare to 2013 Curriculum and identification on teachers constrain to conduct a science practical works in school. Quantitative data were collected by the use of descriptive research method by questionnaire instrument from 37 high school science teachers in Garut regency, West Java. Comparative analysis about the real practical works with 2013 curriculumbasic competencies and teacher's constrain were analysed based on questionnaire and open ended discussion. We obtained that, in average, biology teachers, chemistry teachers, and physics teachers implement practical works respectively are 4.72; 4.57 and 5.15 times/year. Biology teachers, chemistry teachers, and physics teachers implement practical works more than 4 times/year respectively are 63.64%, 63.13% and 71.43%. Recapitulation of all respondents answer shows that compared to basic competencies of practical works on 2013 Curriculum, 71% chemistry teachers already conducted the minimum competencies then respectively 72% and 85% biology and physic teacher also fulfil the basic competencies of practical works. The main constraint for teacher is limited school time and lack of practical equipment. Factual effort to improve teacher's ability to conduct a science practical work will be explored.

Keyword: Critical Thinking, Teacher Constrains, Science activity, Problem Solving, Practicum, Laboratory Activities.

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INTRODUCTION

Practical works play an important roles in science education and this statement is widely accepted and it is acknowledged that good practical work encourages students to have more engagement and interest as well as developing a range of skills, science knowledge, and conceptual understanding [1]It is believed that the heart of science discipline is a practical works, if the students have zero experience in the practical works, all what have been learnt just become inert knowledge [2].

As cited in Ergul (2011) [3], the use of science process skills by practical works on students increases the permanence of learning. By practical works, when students have learning by doing process, student uses almost all of his or her senses and learning becomes more permanent and hands-on activities get them to acquire experience. The development of science process skills through practical works enables students to solve problems, think critically, make decisions, find answers, and satisfy their concerns and generally improve their important life skills for their future. Besides, there are some advantages of practical works based on pervious study, Martindill and Winston stated that doing practical work in learning process have numerous advantages for students. First, it was supported students' visualisation of abstract concepts and provided a stimulus for the recall of key facts later. Second, it provided a distinctive opportunity for students; to work collaboratively, with associated gains. Finally, hands-on tasks promoted a classroom atmosphere rich in variety, semi-autonomous learning and self-discovery, which students found intrinsically motivational [4].

Fundamentally, science practical works is a model of learning that aims to strengthen students understanding of science concept through independent works when students find their own answer or validate the science concept by their own [4].Mel Silberman in his book Active Learning: 101 Strategies to teach any Subject quotes one of the Confucius views which states that '*what I do, I understand*'.This statement supports the theory that teachers who provide a lot of activity in the form of science learning can support students to have the better and all of the science process skill merelyobtained through practical works/ science experimental activities [5, 6].

Though, by a direct observation and discussion with teachers who have participated in SEAMEO QITEP in Science (SEAQIS) training, they stated that science practical works in school are hardly ever conducted. According to teachers, the limitation of practical works occur for several reasons such as lack of laboratory equipment, limited school time, lack of students manuals, etc. This condition has occurred in a relatively long time, nevertheless valid quantitative data of the number of science practical works done by high school teachers is still very limited. In order to obtain a clear picture and valid data about the science practical works, SEAQIS conducted a study aimed to identify the real frequency of science practical works in High School of Garut Regency and also identify the type of science practical works that frequently conducted of the high school teachers then compare it to minimum students competencies based on 2013 Curriculum. This study also eager toknow the obstacles for teachers to conduct science practical works, as a basic understanding to improve the implementation of science practical works in school. Result of this study can be the foundation for various parties, especially the relevant stakeholders to find solutions and mendhurdles for implementation science practical works in order to provide a more effective learning process for student's better understanding.

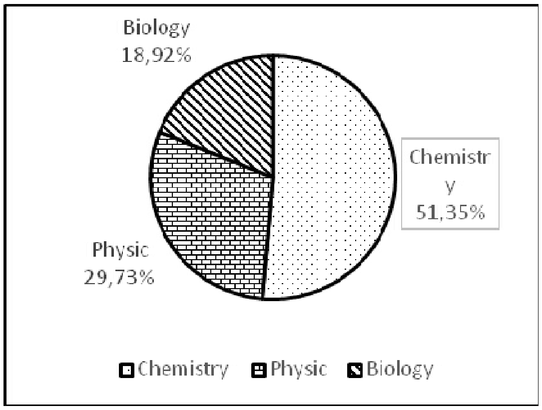
MATERIAL AND METHODS

The research method used is descriptive survey type research. descriptive research designs help provide answers to the questions of who, what, when, where, and how associated with a particular research problem; Descriptive research is used to obtain information concerning the current status of science practical works in high school in Garut Regency [7, 8]. Garut Regency was selected by a purposively sampling, related to its location which can represent both urban and rural area also as one of SEAQIS training course location. Surveys conducted in science high school teacher who participated in SEAQIS training course, this method are used to collect data or information about large populations using relatively small samples [9]. Descriptive research in the field of education and teaching curriculum is important enough, describe the phenomena of educational activities, learning, and curriculum implementation on various types of levels and educational units [9].

Questionnaire was the main instrument in this study. Questionnaire sheet was consisting of three parts, the first part is the respondent's personal data includes their identity, teaching subject, and grade level they taught so far. The second part is the main question, containing the question of how often the respondents conduct a science practical works in a fiscal year and list of the practical works that they frequently conducted. The third section contains ten statements about obstacles that may occur when conducting practical works, the respondents were asked to validate the statements based on it their experience. As an addition, the participants were asked to answer an open question about the respondent's input to improve science practical works in school. This questionnaire instrument has been reviewed and validate by the research supervisor then it can be disseminated to obtain the necessary data.Personal information data and frequencies of science practical work was obtained and analysed by descriptive statistic and presented in diagram or graph, meanwhile the list of practical work that frequently conducted was compare to minimum amount of practical work learning based on analysis of core and basic competencies number 4 on psychomotor skills in 2013 curriculum for Physics, Chemistry and Biology in High School. Total respondents for this study was 37 science teachers from 28 high school in Garut Regency, Indonesia.

RESULT AND DISCUSSION

Teachers Information: The first data present the subject taught by respondents. Based on the questionnaire 19 respondents (51.35%) was a chemistry teachers while 11 respondents (29,73%) and 7 respondents (18.92%) were physic and biology teachers respectively. In the following is data of grade level respondents taught in a fiscal year. The results shows 18 of 37 respondents (48.65%) taught at one level while 7 respondents (18.92%) taught two levels.Because of the some constrains 6 respondents (16.22%) have to teach in three grade levels (10, 11 and 12) at the moment. Unfortunately the rest, 6 (16.22%) of respondents did not fill thequestion. This data is important to give a brief understanding about teachers condition, commonly most teacher who taught two or more level at the same fiscal year will divided their attention and rarely able to focus to conduct a science practical work in their class. The result of the two first questions were presented on the Figure 1.



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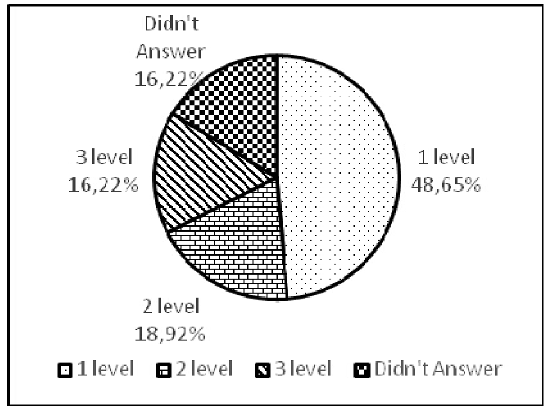

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Figure 1.a. Subject Taught by Respondents; b. Number of Grade Level Taught by Respondents

The next data will present main result of this study. 35.14% science teachers in Garut Regency stated that they conduct practical works around one to three times in a fiscal year and 32.43% stated that they conduct a science practical work more than seven time in a fiscal year. The data for each subject shows, chemistry teachers in Garut Regency conduct more practical works compare to biology and physic teachers. 42.11% chemistry teachers conduct a practical work more than seven times in a fiscal year, while biology teachers and physic teacher who conduct practical works more than seven times just 27.27% and 14.29% respectively. We obtained that, in average, biology teachers, physic teachers, and chemistry teachers implement practical works respectively are 4.72; 4.57 and 5.15 times/year. Based on the data, all respondents stated that at least they conduct a practical works one time in a year. Recapitulation of responses are presented on Table 1.

Table 1. Frequencies of Practical Works Done by Respondents in a Fiscal Year

Subject	**Frequency of Practical Works**	**Respondents's Frequency**		**Average**
Chemistry	0	0	0%	5.15 times/ FY
	1 – 3 times/ FY	7	36.84%	
	4 – 6 times/ FY	4	21.05%	
	> 7 times/ FY	8	42.11%	
Biology	0	0	0%	4.72 times/ FY
	1 – 3 times/ FY	4	36.36%	
	4 – 6 times/ FY	4	36.36%	
	> 7 times/ FY	3	27.27%	
Physic	0	0	0%	4.57 times/ FY
	1 – 3 times/ FY	2	28.57%	
	4 – 6 times/ FY	4	57.24%	
	> 7 times/ FY	1	14.29%	

After collecting the frequencies data, theme of each practical works that usually conducted by teacher were analysed. Each teacher ideally should implement ascience practical works based learning in accordance with the 2013 curriculum [10], it stated there are a minimum amount of science practical works or experiment-based learning based on analysis of core and basic competency (BC) 4 on psychomotor skills in Physics, Chemistry and Biology in High School. The results of analysis of basic competencies that should be conducted in experiment-based learning are contained in table 2.

Table 2. The Minimum Number of Experiment-Based Learning Per Year Based on the 2013 Curriculum

Subject	Chemistry		Biology		Physics	
Class	Ideal Freq	BC list	Ideal Freq	BC list	Ideal Freq	BC list
X	6	4.1, 4.5, 4.6, 4.7, 4.8, 4.9	7	4.2, 4.3, 4.5, 4.6, 4.7, 4.8, 4.9	8	4.2, 4.3, 4.4, 4.5, 4.6, 4.7, 4.10, 4.11
XI	11	4.5, 4.6, 4.7, 4.8, 4.9, 4.10, 4.11, 4.12, 4.13, 4.14, 4.15	8	4.1, 4.3, 4.4, 4.6, 4.7, 4.8, 4.9, 4.10	5	4.2, 4.3, 4.5, 4.9, 4.10
XII	7	4.2, 4.3, 4.4, 4.6, 4.7, 4.8, 4.9	5	4.1, 4.2, 4.3, 4.4, 4.10	4	4.1, 4.2, 4.3, 4.4

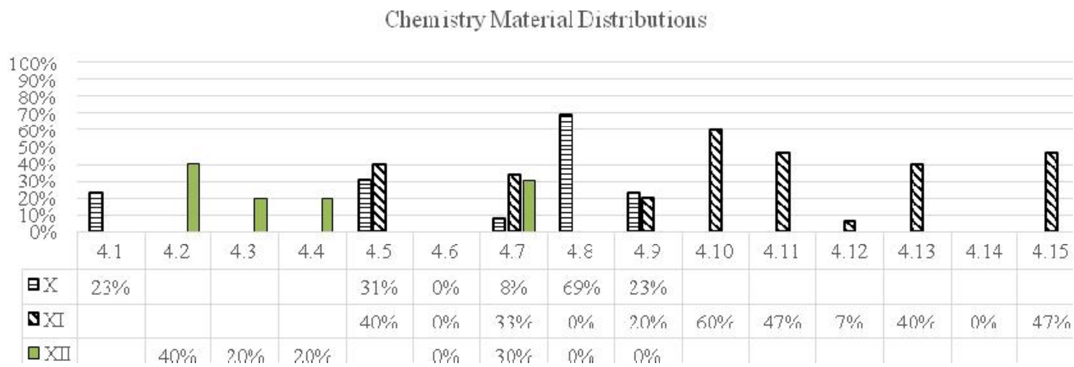
This data was compared to the response from science teachers in Garut Regency. Implementation of science practical work conducted by High School teachers of Physics, Chemistry, and Biology in Garut regency in accordance with minimum competencies in 2013 curriculum are shown in table 3.

Table 3. Implementation of Experiment-Based Learning in Garut Regency PerFiscal Year

Subject	Chemistry			Biology			Physics		
Class	Ideal Freq	Freq	%	Ideal Freq	Freq	%	Ideal Freq	Freq	%
X	6	5	83 %	7	4	57 %	8	6	75 %
XI	11	8	73 %	8	8	100 %	5	4	80 %
XII	7	4	57 %	5	3	60 %	4	4	100 %
Average			**71 %**			**72 %**			**85 %**

Table 3 shows that most of the competencies in 2013 curriculum has been implemented in science practical work at high school in Garut Regency. However, this data use the response from all science practical work lesson from all the respondents, not from each individual. So the high average number isn't represent each individual but for all respondents.In total average, 76% of science practical works based on2013 curriculum competencies already conducted in school. As for the each subject, 71% chemistry teachers already conducted the minimum competencies for science practical works then respectively 72% and 85% biology and physic teacher also fulfilthe minimum competencies of practical works. The highest achievement of science practical work is showed on biology grade XI and

Physic grade XII, it means based on questionnaire result, all the science practical work that consider as minimum competencies was already conducted within the group of respondents. However, that achievement is not experienced by all teachers.However, even the comparison between minimum competencies and field study data was considerably high, based on figure 2, the percentage of teachers who was performing of all the theme are still small, it means there are only some teacher who completed the minimum BC on science practical works.



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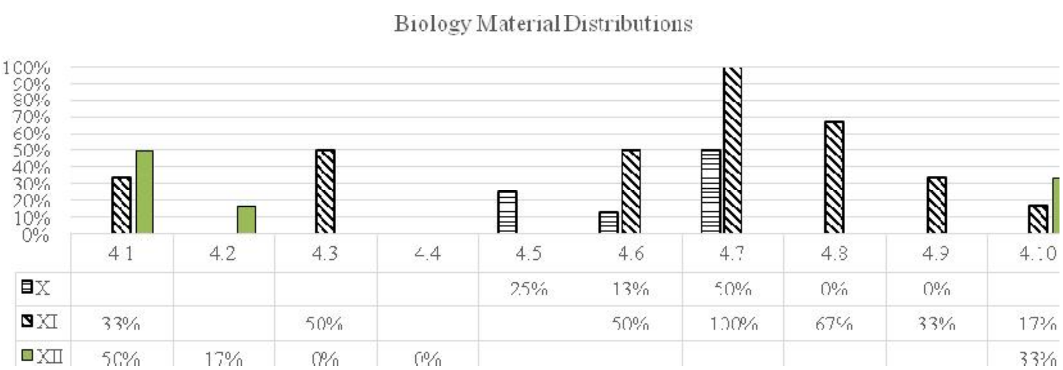

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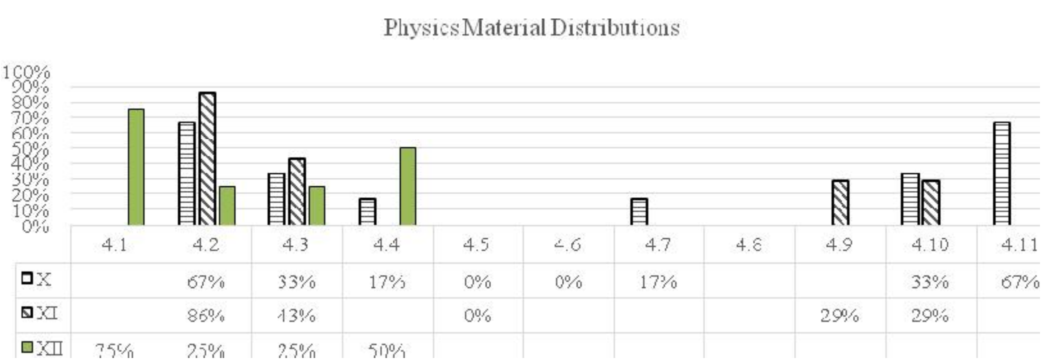

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Figure 2. Percentage of the Teachers Who Was Conducted a Practical Works for Each Basic Competencies (a) Chemistry, (b) Biology, (c) Physic

Figure 2 shows the percentage of teacher who was conducted a practical works for each BC in each subject. The empty boxes on the figure indicates that there are no practical works designed in that BC meanwhile the 0% on the boxes indicates that there are an activity of science practical works on that BC, however there is any teacher conducted that practical works. Based on figure 2, we can conclude that there is a significant gap between the most frequent lesson and the less frequent lesson in each subject. Explanation of the science lesson that conducted most for practical works in high school and the result were presented in Table 4.

Table 4. Science Practical Works Lesson Most Frequently Carried Out by Teachers in Garut Regency

Subject	Physics			Chemistry			Biology		
Class	**BC**	**Material**	**%**	**BC**	**Material**	**%**	**BC**	**Material**	**%**
X	4.2	Measurements	67%	4.8	The conductivity of the solution of solutions	69%	4.7	Biodiversity	50%
	4.11	Simple Harmonic Motion	67%						
XI	4.2	Elasticity and Hooke's Law	86%	4.10	Acid-base properties	60%	4.7	Food substance test	100%
XII	4.1	Direct current circuit	75%	4.2	Ionizing degree	40%	4.1	Plant growth and development	50%

As predicted, the list of lesson in table 4 are the lesson which are easily practicable, related to the depth of material at each grade level and have simply tools and materials. Based on respondents answer, the most frequent science works conducted in grade X is conductivity of the solution (69%) for chemistry, biodiversity (50%) practical work for biology then measurement (67%) and simple harmonic motion (67%) for physics. And for the rest grade, the most frequently conducted practical works is presented on Table 4. All the lesson on table 4 is mostly conducted by all respondents in each respective subject, on the other hand other lesson which aren't show in table 4 are performed only by one or two respondents. Contrary to table 4, table 5shows the science practical work that almost never done by the respondents of Physics, Chemistry, and Biology teachers in Garut Regency during one fiscal year.

Table 5. Science practical Work LessonRarely Implemented by Teachers in Garut Regency

Subject	Physics		Chemistry		Biology	
Class	**BC**	**Material**	**BC**	**Material**	**BC**	**Material**
X	4.5	Parabolic motion	4.6	Molecular shape model	4.3	Cladogram classification of living things
	4.6	Circular motion			4.8	Phenetic and phylogenetic analysis of plants
					4.9	Layers of animal body
XI	4.5	Thermal characteristics of material	4.6	Uncontrollable change		-
			4.8	Reaction equilibrium constant		
			4.14	Separation of ions in solution		
XII		-	4.6	Gilding	4.3	Protein synthesis
			4.8	The properties of amphoteric aluminum (Al^{3+})		
			4.9	Synthesis of carbon compounds and functional groups	4.4	Cell division

The lesson contained in table 5 is rarely conducted by the teachers hence this lesson was consider as difficult material for each grade level, both content and tools and materials. Most or the lesson in Table 5 needs a advance tools, skills to performs or simply needs more creativity for teachers to conduct a practical works in the limited time. As example, layers and animal body is the practical works that rarely conducted in biology subject since to carry out this practical work, teachers need a slide of animal tissues and decent microscope, which is not present in most of school laboratory.In addition to tools and equipment difficulties, there are common obstacles that are felt and experienced by teachers in Garut regency so that the experiment-based learning is difficult to be implemented ideally according to 2013 curriculum. Based on the questionnaires, the teacher's main constraints are shows on the graph in the Figure 3.

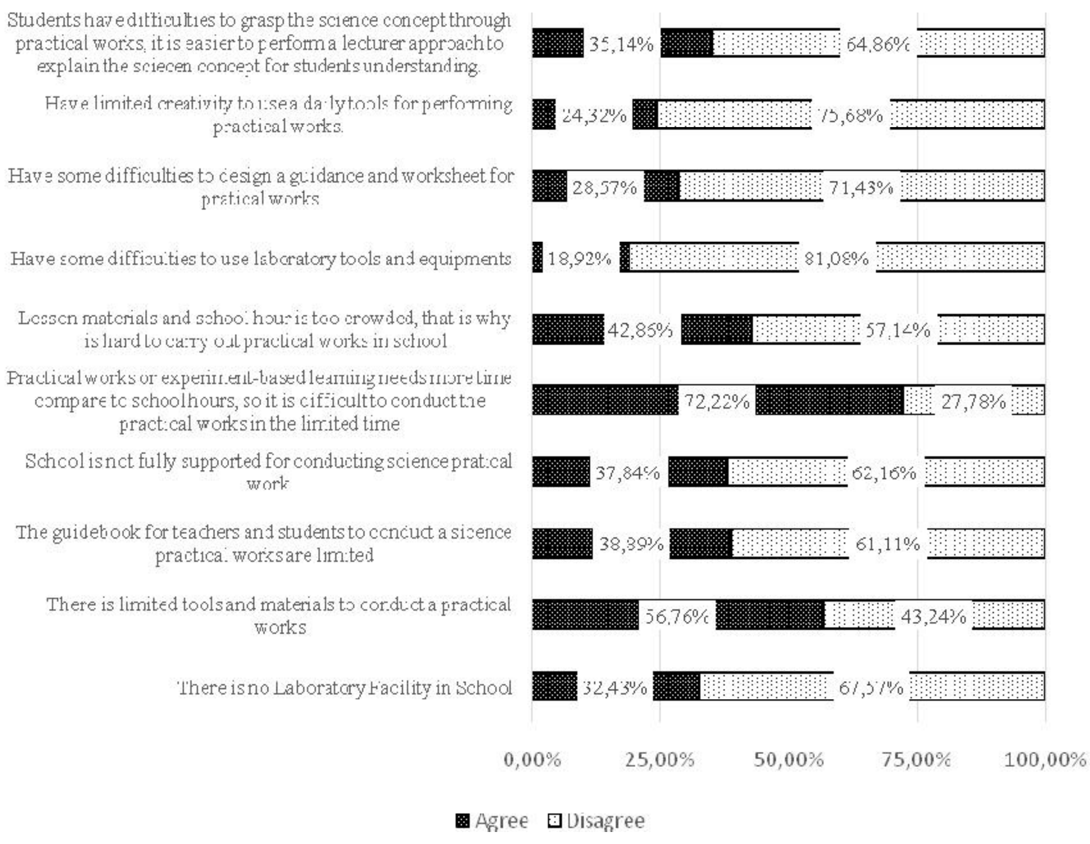

Figure 3. Statements of Teachers Constrain in Conducting Practical Works

Based on data as presented in Figure 3 and discussions with science teachers in Garut Regency, majority of teachers stated that science practical works is considered as important process of science learning in schools, this is proven from the data in Table 1 that shows every teacher conduct at least one practical work in a fiscal year. However, the percentage of teachers who practiced only 1-3 times/ FY is relatively significant which means there are some difficulties experienced by teachers that leads them to have a limitations in performing science practical works in the learning process.

Common difficulties to conduct a practical works was listed and respondents were asked to give their agreement or disagreement for each statements. Figure 3 shows the main constraint for teachers in Garut Regency for conducting practical works is the limited school hours (72,22%) and limited of tools and materials in school (56.76%). The statement stated that practical works or experiment-based learning needs more time compare to conventional learning and school hour, so it is difficult to conduct the practical works in that limited time. It was understandable because of practical works in general take a relatively long time meanwhile the science lesson hour in high school is limited. In 2013 curriculum in average science was scheduled about 4 hours a week and it was divided into two meetings for each science subject.Based on the assumption that one lesson hour is take about 45 minutes, the maximum duration of activity in science learning activities is 90 minutes. Within that time constraint teacher stated that not all the science practical works can able to conduct in high school. Because they felt that they did not have sufficient time to perform the stages of practical work activity from preparation up to discussion of conclusion.

This result also linear to the research by Yennitaet. al., in Pekanbaru City which also stated that 48% of teachers stated that the available time was not sufficient to complete an experiment, not to mention the teacher had to prepare the lab and set up various equipment then clean up the lab after work finished [11]. To solve these constraints, time management becomes an important point for teachers,it suggested to do a preparation before the class started and if possible, teacher can collaborate with laboratory assistant to prepare the tools beforehand. In addition, enrichment of science practical work outside of school hours can be a solution to the limited lesson time.For some practical works related to observation of natural phenomenon or lesson that doesn't need an advance tools, students are encouraged to do a practical work outside the school hours, then discuss further about the concept in the classroom.

The second constraint of teacher is limited tools and equipment for conducting practical work. Agreement of this statement was in line with some suggestion from respondents in discussion session. High school teacher in Garut stated that there are inequity related to science kit (tools and materials for laboratory activity) distribution in Garut Regency. Most of the respondents affirmed Ministry of Education have distributed the science kit since 2010, however not all the school were given, public and favourite school were more favour than relatively unpopular school. Effective distribution from Ministry of Education or initiative from the school to get the science kit from other source will be appreciated to disentangle the problem related to limitation of tools and materials for science practical works. All of this data about real conditions in Garut Regency High School can be used as a reference to the effective implementation of science practical work in the surrounding cities. That it is necessary to adjust the content and the allocation of learning time so that learning can be done effectively and efficiently, so that experiment-based learning as the core of science learning can also be done well and beneficial for student self-development.

CONCLUSION

This study shows, 35.14% science teachers in Garut Regency stated that they conduct practical works around one to three times in a fiscal year and 32.43% stated that they conduct a science practical work more than seven time in a fiscal year. Chemistry teachers in Garut Regency conduct more practical works compare to biology and physic teachers. 42.11% chemistry teachers conduct a practical work more than seven times in a fiscal year, while biology teachers and physic teacher who conduct practical works more than seven times just 27.27% and 14.29% respectively. In average, chemistry teachers, biology teachers and physic teachers implement practical works respectively are 5.15; 4.72 and 4.57 times/year. Compared to basic competencies of practical works on 2013 Curriculum, 71% chemistry teachers already conducted the minimum competencies for science practical works then respectively 72% and 85% biology and physic teacher also fulfil the minimum competencies of practical works. The most frequent science works conducted on science class is conductivity of the solution (69%) for chemistry, test of a food substance (100%) practical work for biology thenElasticity and Hooke's Law (86%) for physics. The main constraint for teachers in Garut Regency for conducting practical works is the limited school hours (72,22%) and limited of tools and materials in school (56.76%).

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