LESSON STUDY FOR BIOLOGY TEACHER: MENTORING PROGRAM OF STEM-BASED LEARNING IMPLEMENTATION IN BOGOR SENIOR HIGH SCHOOL

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Introduction

One of the most prominent in 21st Century is integrated knowledge, so that it makes fastest colaboration. In the context of technology and communications'utilization in education, it is proven that narrowing and fusing the" time and spaces" factor as determination aspect of achievement in people knowledge (BSNP, 2010). Through national curriculum, 2013 curriculum that suport the times are increasing rapidly, especially now that the world is entering an era of technological disruption that has shifted in the Industrial Revolution 4.0 era. This era, marked by the appearance of supercomputers, smart robots, autonomous vehicles, genetic engineering, and the development of neurotechnology that allows humans to be better in optimize brain function (Prasetyo & Sutopo, 2018).

Massive changing in this era becoming a concern of educator to develop quality human resources. One of those effort that is done by the educator is prepare the innovative learning system. berbasis *Science, Technology, Engineering and Mathematics* (*STEM*)-based learning is one of potential alternative learning to be implemented for develop 21st century skill and become learning process 's frame of reference in the future in Indonesia (Permanasari, 2016; Rustaman, 2016). The characteristic of STEM-based learning is integrating science, technology, engineering, and mathematics in real life problem solving. Pfeiffer *et al* (2013) stated that in STEM learning, skills and knowledge are used combining together by the students.

The effort to realize the innovative learning system is a motivation for educator to increase their pedagogical competencies. There are many ways to embody, for instance Subject Teacher Deliberation (MGMP) activities. MGMP itself is the teachers' organization that is established for communication forum that aimed to solve the problem which is faced by the teachers during teaching learning process at school.

The one of MGMP which held the meeting routinely in Bogor Regency is MGMP of Biology teacher. Highly enthusiastic of biology teachers in Bogor Regency appear. It is proven by preliminary study that has been done, the number of participations of Biology teacher in Biology STEM-based learning workshop is high, i.e., 54 members. Based on interview with the members, 100% biology teacher are motivated and interested to implement STEM based learning on their classroom. From the test of STEM knowledge, the results is figure out that explanation about STEM-based learning during workshop are really helpful and increase teacher knowledge.

Based on the results of follow-up interviews, the teacher was very interested in implementing STEM learning. However, there are obstacles faced by teachers when they want to implement them. One of them, as many as 73% think that teachers have difficulty developing STEM-based biology learning tools. And as many as 57% think that the preparation of learning activities with STEM requires time and effort. Seeing the obstacles faced in the field, therefore special assistance is needed in the preparation of STEM learning tools, namely through lesson study.

According to Stepanek (2003) lesson study is a collaborative process in which a group of teachers identifies a learning problem and designs a learning scenario (plan stage), teaches students according to the scenario conducted by one teacher, while others observe (do stage), reflect and evaluate. (see the stage), as well as revising the learning scenario. Assistance with the lesson study approach is expected to maximize cooperation between integrated teachers in improving teaching competencies. Together to find solutions to any challenges/problems that exist during the teaching and learning process, the benefits of which can be felt directly by students.

Discussion

1. The Steps of Lesson Study in Biology Learning based on STEM-based Learning

MGMP teacher mentoring program in Bogor will be implemented through 2 cycles of lesson study with each cycle consisting of 3 stages, namely: (1) Planning; (2) Implementation (Do), and (3) Reflection (See). The Plan stage in this program will be implemented in two stages, namely Plan 1 and Plan 2. In the Plan stage, the teacher analyzes basic competencies from curriculum which can be applied using the STEM approach. Furthermore, the teacher is guided by the team to analyze the problems/conditions of students in the target class, analyze the conditions of learning facilities and facilities in the classroom, design STEM-based biology learning designs, and compile STEM-based biology lesson plans (RPP).

The Do stage is carried out in 3 zones involving 3 pilot schools, namely SMAN 1 Ciawi, SMAN 2 Cibinong, and SMAN 1 Cibungbulang. At the Do stage, there are two main activities, namely: (1) learning activities carried out by one of the agreed teachers or at his request to practice the lesson plans that have been compiled together, and (2) observation or observation activities carried out by members of the another community lesson study.

Reflection stage are carried out in the form of discussions in which all Lesson Study participants are guided by the principal or other designated participants. From the results of reflection can be obtained several new knowledge or important decisions for improvement and enhancement of the learning process, both at the individual and managerial level. The teacher's response to this mentoring activity was obtained by distributing questionnaires. The questionnaire was used by researchers to determine the teacher's response to the implementation of activities.

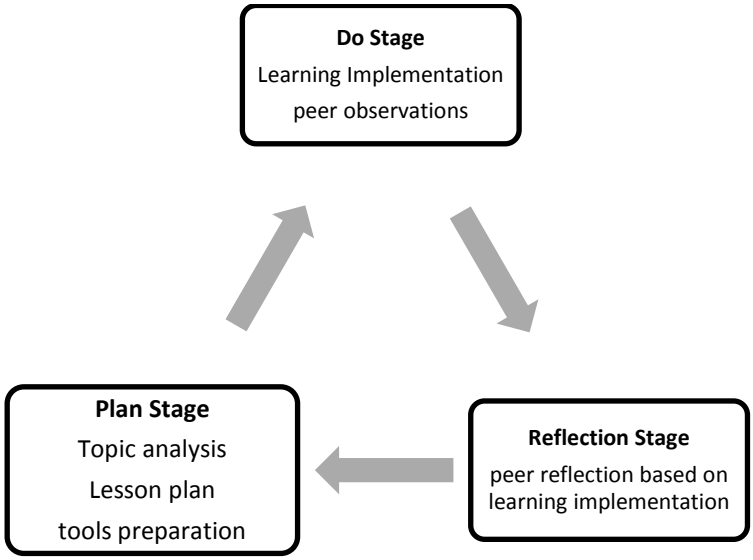

Figure 1. Lesson Study Steps

2. STEM-based Learning Implementation in Biology Classroom: Cycle 1

Lesson study activity consists of Plans, Do's and Sees each in three different schools. Plan activities are carried out together in one place, while Do and See activities are carried out in 3 different schools in 2 cycles. Plan 1 activities were carried out together at SMAN 2 Cibinong. In this initial activity, all teachers were given an explanation about the Lesson Study, followed by each group making a Lesson Plan.

The division is as follows: 1) Group 1: SMAN 1 Ciawi with the topic of biotechnology in class XII, 2) Group 2: SMAN 2 Cibinong with the topic of the Movement System and Respiratory System in class XI, 3) Group 3: SMAN Cibungbulang with the topic of Bacteria in class X.

Figure 2. Plan Stage on Cycle 1 Activity

After Plan 1, the Do 1 activity was carried out at SMAN 1 Ciawi. As for the Do, what the teacher did was that at the beginning the teacher carried out interesting and contextual preliminary activities so that it aroused student interest in further learning activities. After carrying out preliminary activities the teacher explains a little of the main material and continues with giving discussion sheets to students. On the discussion sheet students design a food product using the principles of biotechnology but do not interfere with health. The discussion process is complete, students present the results in groups. After each student presents the results of their discussion, the teacher asks other friends to respond to each other. The teacher also provides direction and input. After all of them have finished presenting the results of the discussion, the teacher assigns students to make what they have designed at home.

The results of the See 1 process are based on the results of observations as a whole that students are enthusiastic about learning activities. Some students who were less enthusiastic during the learning process became notes to the observer. The student's lack of enthusiasm was because the shape of the table that had been arranged did not support them in discussing each other. These students will become target students whose learning activities are enhanced at the next meeting. During the discussion, students also use various kinds of literature as a learning resource. It's just that the results of their discussion do not seem to bring up the STEM aspects, especially the Mathematical aspects.

Figure 3. Do and See Stage on Cycle 1 Activity at SMAN 1 Ciawi

The Do 1 activity at the second school was at SMAN 2 Cibinong. In this activity, the students made a muscle contraction mechanism model with the tools and materials determined by their respective student groups. At the beginning of the lesson, the teacher explains the concept of the mechanism of muscle movement. Furthermore, students make a model/design of the image of the mechanism of muscle movement. Through this image design, students can determine the tools and materials needed in designing the model. Before learning, the teacher has informed about the activities that students will do, so that students have brought various equipment and materials that will be used to make models.

After the Do stage, then See stage activity was carried out, based on the results of observations on 6 groups of students, it was found that students' creativity in designing muscle movement model designs had appeared, but the engineering and mathematical aspects had not been demonstrated by the students. Students design and make models without considering the length of the material (mathematical elements) and designs that are made without considering the effectiveness of the design (elements of the engineer). This causes students to make products with an estimated size and shape so

that none of the test results on the model match the target achievement. Good collaboration and communication were shown by two groups of students, while the other 4 groups still dominated several group members. The students in this class have just implemented STEM-based biology learning, so the learning tasks they carry out do not involve all STEM elements. However, STEM skills can be trained in students through a process of habituation.


Figure 4. Do and See Stage on Cycle 1 Activity at SMAN 2 Cibinong

The Do activity was also carried out at the SMAN Cibungbulang. At the beginning of the learning activity, the teacher displayed a picture of a TB (Tuberculosis) sufferer, a picture of the lungs of a TB patient as well as statistical data about countries that suffer the most from TB. The impressions displayed by the teacher suddenly attract the attention of students, so that students become focused and ready to receive lessons. After that, the teacher asked several questions related to TB diseases, such as the causes of TB disease and others and the students spontaneously answered the questions. Then the teacher invites students to get to know the bacteria that cause TB disease, how it is transmitted and how to treat it. The teacher asks students to group and looks for information about plants or herbal ingredients that can be used as natural antibiotics to treat TB disease. After finding the necessary information, students are asked to design and manufacture a natural antibiotic medicinal product from plants or other herbal ingredients as an alternative medicine to chemical drugs. The results of the design that have been carried out, students get several natural alternative medicines that can be given to TB sufferers including; soursop leaves, *lempuyang*, mangosteen peel, hibiscus. From the design that has been made, the teacher asks students to make alternative medicine outside the classroom, and at the next meeting, it is displayed. The teacher closes the lesson by reviewing the material and concluding with the students.

After completing the Do activity, a See stage is performed. The results obtained indicate that the learning that has been done makes students actively participate in learning. This can be seen also from the results of the questionnaire given as much as 90% stated that students were enthusiastic about the learning that had been implemented. Judging from the target students, namely Defran, Joseph, and Rafanasthario. The three people were judged by the teacher to have different abilities from other classmates because usually when learning they were not conducive and were more likely to pay less attention to learning activities. However, when using the STEM learning approach, the three students tend to be more conducive and able to work with their friends, especially when they contribute to group work.


Figure 5. Do and See Stage on Cycle 1 Activity at SMAN Cibungbulang

3. STEM-based Learning Implementation in Biology Classroom: Cycle 2

After all activities in cycle 1 were carried out, the Plan was carried out again for cycle 2. The plan was carried out at SMAN 2 Cibinong. In this activity, the teacher discussed lessons planning that would be carried out next after cycle 1. In the Plan 2 stage, the teachers were joint the same planning to teach and prepare media and teaching instruments based on see activities in cycle 1.


Figure 6. Companion Lecturer Guide Teacher in Plan Stage Cycle 2

The Do activity for the first cycle 2 was carried out at SMAN 1 Ciawi. In this do activity the teacher opened the lesson by asking about the previous material. After that the teacher asks the students to sit in groups and begin to prepare for the exhibition of their products. After everything is tidy, the teacher asks 2 representatives from each group to stay in their place, while other group members will visit other groups. Two representatives who lived in his place were assigned to brief the other visiting group members. And the visiting group members are asked to taste each product and then give an assessment. After all these activities are carried out, the teacher recapitulates the results of the assessment and gives an award to the best group. Furthermore, the teacher summarizes the learning results and gives appreciation for the enthusiasm of the students during the learning process.

After Do's activity, then See was carried out, there were several findings in the learning process that were discussed by the observers. Almost all of the findings were positive because the observer saw the extraordinary enthusiasm of the students. Students who are targeted also experience an increase in learning activities. Although there were still some discussion groups that did not fully bring out the STEM aspects.


Figure 7. Do and See Stage on Cycle 2 Activity at SMAN 1 Ciawi

The second Do activity at Cycle 2 was held at SMAN 4 Cibinong. At this stage, the teacher applies the results of the lesson plan that had been previously designed with other teachers. At the beginning of the student learning activity, a video of several people is shown breathing with several conditions (after running and being quiet). The video presentation that was given turned out to make students focused and ready to initiate learning activities, this was seen from the enthusiasm of the students in watching the video. After giving an apperception about breathing (video), the teacher asks questions related to breathing that aim to explore students' initial knowledge, one of the questions is how the breathing process is, which breathing rate is faster between those who are still and after running. Spontaneously and simultaneously the students answered the questions posed by the teacher with various answers. Then the teacher distributes worksheets that students must discuss, namely about making a product to measure the volume of breathing and the teacher provides several tools and materials that can be used including hoses, water, gallons, markers, and others. When students discussed, several groups found it difficult to plan a product for measuring the volume of breaths. They do not try to find various sources of information to be used as a reference as they should be. Finally, they are even busy looking at the work of other groups to be used as an example or duplicated by the group. However, it turns out that they also cannot apply it in their group with various obstacles. Of

course, this makes students confused and results in frustration with the unsuccessful design. So that this becomes a continuing domino effect, namely the desire to complete the project is reduced and the emergence of mutual dependence between fellow group members. When the learning ended, there were only a few groups who were able to complete the expected project/product.

After the Do stage is carried out, it is continued with the See activity. When learning is complete, all teachers discuss and reflect on the learning process that has been carried out. The learning outcomes that have been carried out can certainly be seen from the products produced by students, namely that only a few groups were able to complete the product to measure the volume of respiration using simple tools and materials. Then when the learning process takes place the teacher does not reinforce for students to look for various sources of information to serve as examples so that it has an impact on students' lack of motivation and innovation in designing a product.


Figure 8. Do and See Stage on Cycle 2 Activity at SMAN 4 Cibinong

The third Do stage activity on cycle 2 was carried out at SMAN Cibungbulang. In this second cycle, a second meeting was held for Bacterias' topic, where at the previous meeting students were asked to design and make herbal medicinal products to treat TB disease. At this second meeting, all groups of students had prepared their presentation materials in the form of powerpoints and liquid herbal medicinal products that they had produced. All groups describe the herbal ingredients they have selected and what each of these ingredients is used for. After the Do activity, See. Based on the results of observations on the performance of 5 groups of students, only 1 group had STEM elements appear in their product. Most of students have not brought up the mathematical aspect when making herbal medicinal products and considering the dosage of the ingredients they use. Each group of students still found at least 1-2 members of students who were passive, both when answering questions in worksheet, group discussions, and class discussions. Like the implementation of STEM in other pilot schools, students in this class have also just implemented STEM-based biology learning, so the continuity of the STEM process needs to be implemented so that students' skills in implementing STEM learning can be improved.


Figure 9. Do and See Stage on Cycle 2 Activity at SMAN Cibungbulang

Based on the description of the activities above, there are several results that we conclude, the development of collaboration between teachers in preparing Biology learning tools with the STEM approach through lesson studies. This can be seen from the results of observations during the activity with reinforced documentation during the activity. Increased understanding of teachers in making biology learning tools with the STEM approach. This can be seen from the results of the questionnaire, more than 80% of the teachers gave positive responses.

The development of collaboration and increased understanding of STEM learning is because all teachers must be directly involved in every stage of lesson study, namely planning, implementing, and reflecting. Hendayana et al. (2006: 10) emphasized that every teacher has the opportunity to do the following things. 1). Identify learning problems. 2). Assessing common learning experiences. 3).

Choosing an alternative learning model used. 4). Designing a lesson plan. 5). Assessing the advantages and disadvantages of the alternative learning model chosen. 6). Carry out learning. 7). Observing the learning process. 8). Identifying important things that occur in student learning activities in class. 9). Reflect together on the results of classroom observations. 10). Take valuable lessons from each process carried out for the benefit of improving the quality of the process and other learning outcomes. The involvement of teachers in these activities develops collaboration and increases teacher understanding of the implementation of STEM learning.

Conclusion

In general, teachers can develop their pedagogical skills in applying Science, Technology, Engineering, and Mathematics (STEM) -based biology learning in their respective schools and classes. In addition, this activity provides insight and experience to teachers regarding learning strategies in implementing the 2013 curriculum. MGMP teacher development program in Bogor is implemented through 2 cycles of lesson study with each cycle consisting of 3 stages, including plan, do, see. Involving 3 pilot schools, namely SMAN 1 Ciawi, SMAN 2 Cibinong, and SMAN 1 Cibungbulang. The activities carried out increased collaboration between teachers and 80% stated that this activity increased teacher understanding in implementing STEM learning in schools.

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