Teachers’ handicap in conducting learning process using scientific approach: a case analysis of in-house training results of senior high school teachers

I W Subagia*, I G L Wiratma and I N Selamat

Chemistry Education Department, Universitas Pendidikan Ganesha, Bali, Indonesia

*wayan.subagia@undiksha.ac.id

Abstract. This paper aimed at describing and explaining teachers’ handicap in conducting learning process using scientific approach. This case study involved 25 senior high school teachers of SMA Negeri 1 Rendang, Karangasem, Bali and conducted in the form of in-house training. This training was conducted for preparing teachers to implement the 2013 Curriculum. During the study, these teachers were treated as students following a teaching learning process using scientific approach. All teachers involved in five steps of learning, namely: observing phenomena, asking questions, collecting data, associating data, and communicating results. The results of this study revealed that teachers have handicap in doing observation, writing observation results, formulating questions, and using hand phone to find information. Teachers have no problems in writing report and communicating findings. Based on these results, it is suggested that the school should improve teachers’ knowledge and skills about scientific approach, particularly using the so called 5M learning strategy and hand phone to support learning processes.

1. Introductions
The implementation of 2013 Curriculum requires a shifting paradigm of learning from the so-called teacher centered learning to the so-called student centered learning. This learning paradigm introduces widely throughout the school in Indonesia as one of curriculum recommendations. The government of Indonesia, in this case the minister of education and culture, has a policy to use scientific approaches as a method of learning for all subject matters. Moreover, all processes of learning are set out by minimum requirement called standard including content of learning, process of learning, and the evaluation of students’ learning achievement [1, 2, 3].

There are several models of learning recommended by the government of Indonesia in implementing the 2013 Curriculum, namely: discovery learning, problems based learning, project based learning, and learning through 5M learning strategy [2]. The 5M learning strategy consists of several learning activities, namely: observation, question, data collection, data association, and findings communication. This learning strategy is the simplification of the complete process of scientific processes required in scientific method involving nine steps of learning, namely: observation, problem formulation, hypothesis formulation, investigation design, conducting investigation, collecting data, analyzing data, formulating conclusion, and reporting finding [4]. Mastering process skills, such as observing, questioning, collecting data, and associating data to solve problem are important to enhance critical dan reflective thinking skills [5]. Therefore, it is expected...
that by the simplest step of scientific processes including only five steps out of nine will help teachers to teach students using scientific ways of learning or “scientific outlook” [6].

The fact shows that at present, many teachers do not use scientific approach yet in performing teaching learning process. Most teachers still use the so called conventional model of teaching in which learning activities are dominated by teacher activity [7, 8]. Laboratory is not utilized optimally due to lack of laboratory assistant and the limitation of laboratory facilities [9]. Other teachers focus learning activity to fulfill the requirement of national examination only. So, the learning process is focused on exercising students to solve problems usually appeared on exam [10]. Many teachers do not feel confidant to use innovative model of learning and still believe that teaching is a transfer of knowledge [11].

In accordance with those classical problems of the used of method of learning, several learning innovations have been done by researcher and educators, such as the use of learning cycle [7, 12, 13, 14], the used of cooperative model of learning [8, 15, 16], the use of problem solving model of learning [9], the use of project based model of learning [17], the use discovery model of learning [18], inquiry model of learning [19]. The results show that the use of innovative models of learning produces better quality of learning and students’ learning achievement. However, most of those learning innovations are conducted during research only.

The implementation of scientific approach in learning is in accordance with the enhancement of process skills, critical thinking skills, and reflective thinking skills. Sukiniarti [20] who conducted study about process skills of elementary school teacher in Java found that the implementation of process skills is possible to be used in learning. However, attention should be given due to its difficulty and restrictions faced by teachers, such as school facilities and time allocation. Demir [6] who evaluated critical and reflective thinking skills of 30 teacher candidates enrolled in science teaching department of a university in Turkey found that although teacher candidates provided critical and reflective thinking skills, the frequency of responses in terms of illustrating the teacher candidates’ stance towards thinking skill showed lack distribution. Sastrika, et al. [17] who did an experimental research comparing between the used of project based and conventional model of learning found that students learnt by using project based learning producing higher critical thinking than that students learnt by using conventional model of learning.

The 5M learning strategy requires students to learning through activities involving observing natural phenomena, asking question, collecting data, associating data, and communicating results. Through these learning activities, students are facilitated to learn how to do observation, ask question, collect data, associate data, and communicate findings. Observations is a learning activity conducted based on the use of appropriate human senses, such as seeing, listening, earing, smelling, and tasting. Asking question is a learning activity conducted as the representation of curiosity or willingness of students to learn or to know. This activity is related to the observation results because the observation result is used to initiate questions. These two activities are assigned as individual learning to see the differences among learners. Collecting data is a learning activity conducted to find evidences that can be used to answer the questions which is done in groups. Associating data is a learning activity conducted to analyze and synthesize data to be used to answer the questions which is also done in groups. Communicating result or finding is a learning activity conducted, both in terms of written and oral. This activity facilitates students to practice how to communicate in front of classroom and how to write report.

The implementation of the 2013 Curriculum is recommended step by step by the government since 2013. SMA Negeri 1 Rendang is one of state senior high school that just implemented this Curriculum by the year of 2017. Teachers at this school learnt the implementation of this curriculum throughout various media, such as internet, training conducted by education board, and from their colleagues. It can be said that they do not have specific training for managing learning process based on 2013 Curriculum. This situation is used as the main reason to train teacher to prepare learning strategy recommended by the curriculum.
The aims of this study were to describe and explain teachers’ problem in following learning process using scientific approach. This in-house training aimed at improving teachers’ competence in facilitating student learning using 5M learning strategy. The focus of this case study is the capabilities of teachers to do observation, ask question, collect data, associate data, and communicate or report findings in learning process.

2. Methods
This study was a case study conducted at SMA Negeri 1 Rendang, Karangasem, Bali. There were 25 teachers involved in this study. These teachers consisted of the teacher of biology, physics, chemistry, mathematics, social science, Indonesian language, and English. During the training, these teachers were treated as students who follow teaching learning process using scientific approach and 5M learning strategy. Since all teachers have different knowledge background, the topic of learning used was a general topic called “combustion.” In all processes of learning, teachers were asked to observe the given natural phenomenon, write his or her observation results, discuss and choose appropriate observation results, ask questions based on selected observation result, collect data to answer questions, associate data to formulate answers, and communicate findings orally and written. The analysis of teachers’ handicap towards scientific processes was done in accordance with the step of learning involved in 5M learning strategy i.e. observation techniques and results, questions formulation, data collection techniques, and findings communication.

3. Results and Discussion
3.1. The processes of learning
The process of learning based on scientific approach was conducted step by step by following the stages of 5M learning strategy as follows. First, the trainer demonstrated a lighted candle covered by beaker glass as an example of combustion. Second, all teachers were asked to observe the phenomenon and write his or her observation result in a piece of paper individually. Third, the trainer collected the observation results and showed all results on the screen. Fourth, the trainer asked teachers to discuss observation result one by one and decided whether it is appropriate or inappropriate results based on the given phenomenon. Fifth, the trainer asked teachers to decide one appropriate observation result that would be used for further learning. Sixth, the trainer asked teachers to write a question based on the selected observation result individually. Seventh, the trainer asked teachers to discuss the question and choose appropriate question to be answered. Eight, the trainer asked teachers to work in group to answer the questions. Ninth, the trainer asked the group to present their answer in front of classroom.

The learning process was conducted well. All teachers participated in each step of learning, such as doing observation, writing observation results, discussing observation results, formulating questions, discussing formulated questions, and answering the question in groups.

3.2. The observation techniques and results
The phenomenon observed was the lighted candle covered by beaker glass. All teachers observed the phenomenon from the place where he or she sited. So, they observed the phenomenon just by seeing or using their eyes only. The observation results reported were as follows.

1) The candle lighted after covered by beaker glass (wrong)
2) The light is off because of no air (wrong)
3) The light is off doe to no oxygen (wrong)
4) The light is off (right)
5) The light is off because no air entering the glass (wrong)
6) Because no air circulation (wrong)
7) The light is burned (wrong)
8) A beaker glass with candle (wrong)
These observation results indicate that teachers are not able to write observation results correctly. The result number one is wrong because it is not in accordance with the fact. The fact is the lighted candle was covered by a beaker glass. It is not true that the candle lighted after covered by beaker glass. This can be seen as a language problems of teachers. The result number two is wrong because it is not a fact, but it is an explanation of fact. The instruction is to observe the phenomenon and not to explain it. The same results can be seen to the result number 3, 5, and 6. The results number 4 is right because it reported a fact. The result number 9 reported a fact, but it is a trivial observation result.

3.3. The questions formulation
The observation results selected for further learning was the result number 4 which states “the light is off.” The questions formulated based on the observation results were as follows.

1) Why the lighted candle is off after covered by a beaker glass?
2) Why the lighted candle is off?
3) Is the lighted candle inside the beaker glass off?
4) What are the factors causing the lighted candle off?
5) What is the reaction of candle after covered by beaker glass?
6) How long does it take to the lighted candle off?

These questions show that most teachers could formulate questions. The types of formulated questions are Why, What, and How questions. However, some questions are not relevant to the selected observation results, such as question number 3 and 5. The question number 3 is a “yes or no” question and it is not relevant to the selected observation results. The question number 5 is an informative question, but it is not in accordance with the observation results. The question number 1, 2, 4, and 6 are considered as appropriate questions.

3.4. The data collection techniques
There were two questions selected to be answered in this training. These questions were “Why the lighted candle is off?” and “What are the factors causing the lighted candle off?” Teachers found information through internet by using their hand phone and discussed the questions in group. Many teachers did not capable to use hand phone to find information. Most of information used to answer the questions was obtained from his or her knowledge background or the so called prior knowledge. In group, teachers discussed the answer of the questions based on their prior knowledge and experiences.

3.5. The data association techniques
In group, teachers associated the information and formulated their answer together. The answer of those two questions are as follows.

Q1: Why the lighted candle is off?
   A1.1: Because the number of oxygen required for burning is not enough.
   A1.2: Because the number of oxygen inside the beaker glass is reducing.
   A1.3: Because there is no oxygen inside the beaker glass.
   A1.4: Because the number of oxygen inside the glass is smaller compare to outside of the glass.

Q2: What are the factors causing the lighted candle off?
   A2.1: Lack of oxygen and low pressure inside the glass.
   A2.2: The number of oxygen and the pressure inside the glass is smaller than that outside of the glass.
   A2.3: The oxygen concentration.
   A2.4: The oxygen concentration and the air pressure inside the glass which is smaller than that outside of the glass.
The answers of questions above reveal that teachers have problems to answer the questions. Some of the answers are not appropriate, e.g. The answer A1.4 mentioning that the lighted candle is off due to less amount of oxygen inside the glass compare to outside the glass. This answer is not right because there is no data that can be used to compare the amount of oxygen inside and outside the glass. Three answers of question two are wrong, namely the answer of A2.1, A2.2, and A2.4. These answers are wrong because they look at from the pressure. In this case, the pressure is not relevant factor as long as oxygen still available. Another factor that contributes to the phenomenon cannot be found, such as the increasing concentration of carbon dioxide (CO₂).

3.6. The reports
Teachers reported their discussion results, both in written and oral. All groups presented their report clearly. However, since the discussion obtained some wrong answers the content of presentation is also wrong. This kind of mistake is also found in their written report. The way to present their report, both oral and written are good. Teacher started presentation with greeting and ending their presentation with offering question. The report is prepared well and written clearly.

Based on the results described above, it is clearly shown that teachers have several handicaps in following the training of the use of scientific approach in learning. If these handicaps do not overcome, it will influence the learning process that will be conducted in classroom. The first handicap is the way to do observation. The results show that most teachers observed the experiment inappropriately. They observed the given phenomenon from a distance. This way of observing experiment is incorrect because it does not allow the use of all senses. The teachers do not know how to do correct observation in which observation should be done as close as possible allowing senses to obtain information [4]. When the teachers were asked to observe the lighted candle inside the beaker, he or she should come close to the experiment and uses his or her appropriate senses to collect data. This mistake is contributed by their previous method of learning in which the learning process was conducted by using conventional model of learning [10, 11]. To overcome this problem, teachers should be trained to use scientific approach in learning frequently. Once they know the correct way to do observation they will able to observe perform appropriate observation.

The second handicap is the understanding of observation results. Observation results is defined as information or data obtained from the use appropriate senses [4]. For examples, color from seeing, smell from smelling, taste from tasting, sound from hearing, and hot or cold and smooth or rough surfaces from touching. Since he or she does not use appropriate senses to observe experiment, so he or she reported wrong observations results. Some of reported results are not considered as facts obtained from observation, but as an opinion coming from his or her thinking (prior knowledge). For example, a reason of why the lighted candle was off. It seems that teachers need to learn the differences between facts and opinion or reason.

The third handicap is the question formulation. Some teachers have problems how to formulate good questions relevant to observation results. There are two things that are needed to be trained to enhance teachers’ skill in formulating questions, namely the type of questions and the content of questions. In this case, the type of question that should be used is the informative questions, such as What, Where, When, Who, Why, or How and should not use yes or no questions. The content of question should be related to the fact, for example the fact shows that the candle was off and the appropriate questions must be the Why and What questions. Therefore, the right questions formulated are “Why is the candle off?” and “What are the factors causing the candle off?” It should not ask like, “is the candle inside the glass off?”

The forth handicap is the use of hand phone as source of learning. All teachers who followed the training had hand phone. However, some of them could not use their hand phone to gain information due to lack of knowledge and skills to use hand phone. The knowledge and skill of teachers to operate hand phone are necessary to be trained because they may learn abundant of knowledge by using hand phone. This will allow them to help students to obtain scientific information by using their hand phone in learning process. The use of information communication technology (ICT), such as computer and
hand phone, should be encouraged in learning [21]. A hand phone can be seen as one of simple and flexible technology that can be used to enhance learning process.

4. Conclusion
It is important to science teachers to have a good knowledge about scientific approach as well as scientific skills. These knowledge and skills are required to facilitate students to learn science and other subject matters utilizing scientific approach. Based on the results of this case study, it can be concluded that teachers have handicap in learning by using scientific approach. This handicap arises due to lack of teachers’ knowledge and experiences in learning by using scientific approach. In the past, most learning experience is fell into the so called expository model. This model does not provide enough opportunities to teacher and students to use scientific methods. Therefore, teachers’ knowledge about scientific processes need to be enhanced as well as their skills to do observation, write observation results, formulate questions based on observation results, and use ICT (hand phone) to support learning process. The enhancement of teachers’ knowledge and skill can be done through continuous in-house training.

References
[1] The Minister Education and Culture of Indonesia 2016 Regulation Number 21
[2] The Minister Education and Culture of Indonesia 2016 Regulation Number 22
[3] The Minister Education and Culture of Indonesia 2016 Regulation Number 23
[4] Martin D J 1997 Elementary Science Methods: A Constructivist Approach (Albany: Delmar)
[5] Tok S 2008 İlköğretim Online, 7 557
[6] Demir S 2015 Journal of Education and Practice 6 17
[7] Rahayuningsih R, Masykuri M and Utami B 2012 Jurnal Pendidikan Kimia 1 51
[8] Fajri L, Martini K S, and Nugroho C S A 2012 Jurnal Pendidikan Kimia (JPK) 1 89
[9] Pusporini S, Ashadi and Sarwanto 2012 JURNAL INKUIRI 1 34
[10] Wiratma I G L 2013 Journal of Cultural Studies 6 36
[11] Subagia I W and Wiratma I G L 2017 Advances in Social Science, Education and Humanities Research, volume 134 131
[12] Subagia I W and Wiratma I G L 2007 Jurnal Pendidikan dan Pembelajaran 14 45
[13] Nurhayati F, Redjeki T, and Utami B 2013 Jurnal Pendidikan Kimia (JPK) 2 191
[14] Pambudi T, Mulyani S and Nugroho C S A 2016 Jurnal Pendidikan Kimia (JPK) 5 78
[15] Jack G U 2017 Educational Research and Review 12 456
[16] Saraswaty S, Masykuri M, and Utami B 2014 Jurnal Pendidikan Kimia (JPK) 3 88
[17] Lina B C, Yamtinah S, and Redjeki, T 2013 Jurnal Pendidikan Kimia (JPK) 3 10
[18] Sastrika I A K, Sadia I W, and Muderawan I W 2013 e-Journal Program Pasca sarjana Universitas Pendidikan Ganesha 3
[19] Istiana G A, Nugroho C S A and Sukardjo J S 2015 Jurnal Pendidikan Kimia (JPK) 4 65
[20] Fajariah N, Utami B and Haryono 2016 Jurnal Pendidikan Kimia (JPK) 5 89
[21] Sukiniarti Journal of Education and Practice 2016 7 150
[22] Mahindo W J, Wachanga S W, and Anditi Z O 2017 Journal of Education and Practise 8 65