

The Quality of Observation Results and Question Formulation of Vocational School Teachers in Scientific Approach Implementation

I Wayan Subagia¹, I Gusti Lanang Wiratma²

Chemistry Education Department

Universitas Pendidikan Ganesha

Singaraja, Indonesia

¹wayan.subagia@undiksha.ac.id, ²lanang.wiratma@undiksha.ac.id

Abstract— The use of the scientific approach as an idea of learning becomes one of the Indonesian government policies in education. This paper aimed at describing the quality of observation results and questions formulation of vocational school teachers in scientific approach implementation. This study involved intensively 20 vocational teachers from a school workshop in Buleleng regency, Bali. The demonstration of a bottle containing colorless liquid placed on the table is used to initiate activities involving teacher's observation techniques, teacher's observation result writing, and teacher's questions formulation writing. The analysis was conducted based on the criteria of observation techniques, results, and questions formulation. The results revealed that the vocational school teachers show poor ability to do observation as well as write observation results and formulate questions. Based on this study, it is suggested that school teachers should be trained intensively to manage student learning using the scientific approach to enhance higher-order thinking skills (HOTS) of students.

Keywords—observation results; question formulation; scientific approach.

I. INTRODUCTION

The scientific approach has been recommended by the Indonesian government to be used as a learning approach in organizing the learning process in schools. For strengthening the implementation of the scientific approach, the learning process should be conducted in terms of integrated learning thematically and directed to the process of discovery and inquiry. Furthermore, to facilitate students to produce creative and contextual products, both individually and in the group, it is suggested to use project-based learning as a model of learning [1]. Based on this recommendation, all school teachers are expected to manage the learning process using a scientific approach and focus on the enhancement of students to develop soft and hard skills. However, the fact shows that many teachers do not implement the scientific approach in organizing the learning process yet. Several types of research reported that many teachers used a direct instruction model of learning [2, 3, 4]. It is argued that this learning model does not give opportunities for students to participate optimally in learning to cause poor quality of learning.

Learning in the 21st century recommends that the learning process should enhance student skills, such as critical thinking, creativity, collaboration, and communication skills [5]. This is in line with the effort to enhance higher-order thinking skills (HOTS) of students. Although the HOTS learning instruction is already used in the basic competency statement of the curriculum, many teachers failed to formulate learning objectives in HOTS levels. Most of the learning objectives formulated by the teachers fell into low order thinking skills (LOTS), such as memorizing, understanding, and applying concepts [6]. HOTS instructional words are usually linked with the instructional words presented on the taxonomy of learning and instruction, such as Bloom Taxonomy. Based on Bloom Taxonomy, HOTS levels are represented by learning instruction from level four until six, namely analyzing, evaluating, and creating [7].

In improving teacher's understanding of HOTS, one of the vocational schools in Buleleng regency in Bali Province ran a workshop regarding the enhancement of teacher understanding about HOTS. The workshop was set out by using a demonstration of the usage of the scientific approach in learning. The demonstration was focused on the improvement of the basic scientific skills of teachers, such as observing natural phenomena and formulating questions based on observation results. Theoretically, HOTS is defined as an ability to think that requires someone to apply new information or prior knowledge and manipulate information to achieve possible answers in a new situation [8]. The prior knowledge of teachers in doing observation and writing questions will be challenged in this workshop. Besides, this workshop will train teachers to do observations and formulate questions. The practice of observation might increase critical thinking in doing observation involving what to observe and how to observe. The practice of writing questions might increase critical thinking in formulating questions involving what to ask and how to ask.

Three main learning activities should be trained intensively to the students in implementing the scientific approach, namely observing, questioning, and formulating hypotheses [9, 10]. Observing is defined as the investigation of facts by

using human senses. Observation results can be classified into two, namely trivial observation and scientific observation [11]. Simply, the trivial observation is defined as an observation result that does not raise further questions or can be understood by without further clarification. The scientific observation is defined as the observation result that raises further questions or needs investigation. The types of questions that need to be trained are the why and how to question because these two questions cannot be answered directly. To answer these questions, the students should use their critical thinking in analyzing the phenomena. Before answering the question, it is important to have clear questions formulation. Therefore, it is necessary to trained students to write good and clear questions formulation. The third important activity is formulating the hypothesis. A hypothesis is a temporal answer to the question that needs to be proven by evidence that is usually obtained from the experiment. The rest of the scientific activities, such as designing investigation, conducting investigation, collecting data, analyzing data, drawing conclusions, and reporting, will be conducted based on the hypothesis since it is aimed to prove the hypothesis.

To begin scientific processes, observation of phenomena is necessary. One way to initiate scientific processes can be conducted by demonstrating the starter experiment [12, 13]. The starter experiment is defined as a simple demonstration of natural phenomena that can be shown in the classroom. Based on these phenomena, students are asked to do observation and write his or her observation results in a piece of paper. This activity can be used to assess the student's ability to do observation as well as to write observation results. This activity sounded easy, but in classroom learning, it requires good learning management. When this activity is conducted the first time, many students may make a mistake due to several factors, such as lack of observation techniques and skills, leading to inappropriate observation results. However, this problem will be reduced through practices. Once they know how to do a correct observation, they will use their knowledge and skill for further process of learning.

Observation can be seen as the first key to scientific methods. Therefore, this technique should be trained intensively from the beginning. Good observation techniques produce good observation results or vice versa. An observation is a technique used to collect information using senses; either nicked or equipped senses [14]. Therefore, observation involves seeing, hearing, smelling, touching, and tasting. If the senses cannot be used directly to observe the object, additional equipment for utilizing senses is required, for example using a thermometer to observe temperature, using a microscope to overcome the limitation of eyes, and using litmus paper to observe the properties of the acid-base solution.

The second important aspect of scientific methods is questioning or asking questions. This includes question types and question formulation or structures. Clear questions produce a clear answer. The Socratic method of questioning defines three categories of questions, namely exploratory, spontaneous, and focused [15]. An explanatory question is used to find out answers of discussed issues. Spontaneous

question is used to respond to the topic being studied. Focused question is seen as a directed question into a particular phenomenon. Based on this category, focused questioning skills can be trained through the results of observation. In this case, the question should be formulated based on observation results. Besides, the question should be formulated well by utilizing appropriate questions words.

II. METHODS

This qualitative study was conducted in a workshop setting involving more than 100 vocational school teachers in Buleleng regency in Bali Province. During the workshop, 20 teachers were involved intensively as learners and the rest of the teachers participated as observers. This workshop focused on the enhancement of teachers' higher-order thinking skills (HOTS) ability. An implementation of a scientific approach using a simple demonstration was conducted by the trainer to begin activities. The figure and procedure of activities were as follows.



Figure 1. A Bottle Of Colorless Liquid

First, the trainer demonstrated a bottle of colorless liquid placed on the table.

Second, the teachers were asked to observe the bottle and wrote the result of observation in a piece of paper.

Third, the trainer discussed the observation results with the teachers and clarified them one by one.

Four, the trainer selected the most appropriate teachers' observation result and asked the teachers to write appropriate questions relevant to the observation results.

Five, the trainer discussed the question formulation and clarified them one by one.

III. RESULTS AND DISCUSSION

There are three main results presented and discussed in this paper, namely: 1) teacher's observation techniques, 2) teacher's observation results, and 3) teacher's questions formulation.

The observation results and questions formulation written by teachers are shown as follows.

TABLE I. OBSERVATION RESULTS AND QUESTIONS FORMULATION

No.	Observation Results
1	Bottle contains water
2	Bottle size 220 mL
3	Lidded bottle
4	Bottle with no label
5	Bottle contains colorless liquid
6	Bottle made of plastic
7	Bottle on the table
8	Bottle is not full
9	Bottle contains water
10	Small bottle contains water
11	Liquid on the table
12	Colorless liquid
13	Liquid filled into bottle
14	Plastic bottle with colorless liquid
15	Water in plastic bottle
16	Bottle contains colorless water
17	Bottle contains liquids
18	Bottle contains colorless liquids
19	Water in a plastic bottle
20	Colorless liquid in a bottle
21	Liquid in colorless bottle
21	Plastic bottle contains water

TABLE II. QUESTIONS FORMULATION RESULTS

No.	Questions Formulation
1	How much is the volume of liquid in the bottle?
2	Why does the bottle contain not full liquids?
3	Why does the bottle contain not full liquid?
4	Why does the bottle contain not full water?
5	Why does the bottle contain not full water?
6	How much is the volume of liquid in the bottle?
7	Bottle of drinking water contains water?
8	What will happen if the bottle full of liquid?
9	How much is the volume of water?
10	Do they all bottle contain not fill water?
11	How much is the volume of water in the bottle?
12	Who is belong to that mineral water bottle?
13	Why does the mineral water bottle contain not full water?
14	What does the mineral water bottle contain not full water?
15	How much is the volume of mineral water in the bottle?
16	How much is the volume of liquid in the bottle?
17	How much is the maximum volume of the bottle?
18	Why the bottle is not filled fully?
19	Why water is not filled fully in the bottle?
20	What is the type of liquid?
21	Why the water in the bottle is not full?

A. Teacher's observation techniques

When teachers were asked to observe the demonstration (a bottle of colorless liquid placed on the table), no one conducted observation close to the object. All teachers observed the bottle from a distance where they sit. This indicates that teachers did not know the correct technique to conduct observation. This incorrect technique would produce inappropriate results of observation. Theoretically, observation should be done as close as possible to the object allowing senses optimally to collect data [16, 17]. Seeing an object from a distance will produce facts of appearances only and the fact may be wrong because of less clarity. It is not possible to collect facts, such as smell, sound, taste, and touch from a distance. These facts should be collected by using appropriate senses, such as sound by hearing, smell by smell, taste by tasting and surface by touching.

In this case, teachers were only asked to observe the demonstration without any additional instruction. This was conducted to allow the teachers to do a free observation, so they might observe the phenomenon optimally using the technique they knew. Since the teachers demonstrated the wrong technique, it can be concluded that the teachers did not know the correct techniques to do observation. This also indicates that teachers have a lack of experience to do observations. Based on these facts, school teachers should be trained to do correct observation before facilitating students to learn to do observation. So, they may train their students to do correct observation in the learning process. If teachers do not understand how to do correct observation, it is not possible for them to teach their students to do correct observation.

B. Teacher's observation results

From 20 teachers who involved intensively in the workshop, it was collected 22 observation results as teacher's responses towards the given phenomena. Two teachers wrote more than one observation results. Those observation results could be classified into three categories, namely scientific observations, trivial observations, and wrong observations. The distribution was significantly unequal. It was found that one observation results (4%) are scientific observation, nine observation results (41%) are considered trivial observation, and 12 observation results (55%) are considered wrong observation. Examples of teacher's observation results are as follows.

TABLE III. THE EXAMPLE OF TEACHER'S OBSERVATION RESULTS CLASSIFICATION

Scientific Observation	Trivial Observations	Wrong Observations
<ul style="list-style-type: none"> • A bottle contains not full liquid 	<ul style="list-style-type: none"> • Lidded bottle • Bottle with no label • The bottle on the table • The liquid is colorless • The bottle containing colorless liquid 	<ul style="list-style-type: none"> • Bottle contains water • Bottle size is 220 mL • The bottle containing transparent liquid solutions • Using the bottle made of plastic • There is water inside the bottle

The observation result that mentions "bottle containing not full liquid" is a scientific observation because this observation results in challenges for further question. This observation result was also considered as correct observation results since it included data or information obtained from the phenomenon. This observation result was a fact collected by using senses (eyes). This observation result was also considered as critical observation because it needs further investigation, for example, the investigation of the volume of liquid. In scientific learning, students should be trained to do critical observation to enhance his or her critical thinking [18].

The observation results that mentioned "lidded bottle, bottle with no label, bottle on the table, the liquid is colorless, and a bottle containing colorless liquid" was considered as trivial observation because these observation results did not challenge for further questions. These observation results showed an understood able fact without requiring any clarification. These kinds of observation results would not lead to further investigation. In learning, students need to be trained to avoid observing phenomena like these, because these are considered as noncritical observation or non-investigative observation [10].

The observation results that mentioned "bottle containing water, the bottle size is 220 mL, bottle containing transparent liquid solutions, using bottle made of plastic, and there is water inside the bottle" are considered as wrong observation results because this information was not considered as facts. This information was categorized as the opinion of observers. For example, when the teacher mentioned "bottle containing water," actually he or she did not know whether the liquid in

the bottle is water or another liquid because there was no information regarding the type of liquid. This observation might be produced due to his or her daily experience at which the teachers usually face drinking water as a colorless liquid. The same reason may also be given for the observations result mentioning "bottle size is 220 mL". The bottle had no label, but the bottle had a size equal to the size of drinking water of 220 mL. This kind of wrong observation results could be seen as misconceptions produced by previous knowledge or life experiences of observers [19]. The important point to be discussed here is the differences between facts and opinions. It seems that teachers do not know the differences between facts and opinions [20]. A fact is obtained from observation using senses, whereas an opinion is obtained from thinking as the explanations of facts. Based on this information, it can be stated that teachers do not know the difference between observation results and opinion. This indicated that teacher training concerning the observation results is badly required [21].

C. Teacher's questions formulation

The selected observation result used to initiate question was the scientific observation mentioning "bottle contains not full liquid". The teachers were asked to formulate a question based on this observation result. From 20 teachers involved in this workshop, it was collected 21 questions. It means that one teacher formulated more than one question. Those questions were categorized into three, namely appropriate questions, inappropriate questions, and wrong questions. The distribution of questions is as follows: 7 appropriate question (33%), 13 inappropriate questions (62%), and 1 wrong questions (5%). Compare to the quality of observation results, the quality of question formulation is better. However, the percentage of inappropriate formulation of the question is high. This indicates that teachers had problems to formulate questions. Examples of teacher's questions formulation results are as follows.

TABLE IV. THE EXAMPLES OF TEACHER'S QUESTIONS FORMULATION CLASSIFICATION

Appropriate Questions	Inappropriate Questions	Wrong Questions
<ul style="list-style-type: none"> • How much is the volume of liquid in the bottle? • How much is the volume of that liquid? 	<ul style="list-style-type: none"> • Why the bottle is not filled fully? • Why the water is not filled fully in the bottle? • What will happen when the bottle contains full of water? • What is the type of liquid? • What is the maximum volume of the bottle? 	<ul style="list-style-type: none"> • Bottle of drinking water containing water?

The appropriate examples of question formulation were questions that are formulated correctly in terms of question structure and its relevance content towards the observation results. There were two different questions formulated based on the observation result, namely "How much is the volume of liquid in the bottle?" and "How much is the volume of that

liquid?" These two questions have similar meanings asking the volume of liquid in the bottle. This question was considered critical because it challenges further investigation that is the investigation of liquid volume. To answer this question, it should be provided equipment, such as a graduated cylinder and a dropping pipette. Before conducting an investigation, it is appropriate to ask to formulate a hypothesis of the volume of liquid. This allows learners to practice predicting or hypothesizing. The investigation will focus on the verification of the hypothesis. This activity will motivate learners to learn due to their involvement in the learning process.

Several questions were formulated inappropriately viewing from the given observation result. Examples of the question, such as "Why the bottle is not filled fully? Why the water is not filled fully in the bottle? What will happen when the bottle contains full of water? What is the type of liquid?" and "What is the maximum volume of the bottle?" were considered inappropriate because they are not relevant to the observation result stating that "Bottle contains not full liquid." These kinds of questions couldn't be used for further process of learning. This information indicates that teachers had a problem with formulating a relevant question [2]. To overcome this obstacle, training for teachers is required. If this condition is neglected, it is not possible to expect the teacher to teach the student to formulate a critical question.

Although only one case, it is important to know that there was a teacher that does not know how to formulate a question. He or she did not know the question structure in which it has question words and question marks. He or she just wrote a statement and end with a question mark (?), for example, "Bottle of drinking water containing water?" Hopefully, this is just the case, but it is still interesting to investigate at large because this could influence the learners in the learning process.

IV. CONCLUSION

Based on the workshop results and discussion, vocational school teachers had poor ability to conduct observation, to write observation results, and to formulate the question. This can be seen as a serious teacher's problem with the implementation of the scientific approach in learning. Furthermore, it is important to take into account that teacher training, particularly about the implementation of the scientific approach is badly required. Otherwise, the idea of enhancing student's capabilities towards HOTS throughout the implementation scientific approach will left far behind.

In the implementation of scientific approach, it is important to understand that the process should be conducted inductively. It can be started from observation, writing observation results, discussing and selecting observation results, formulating questions based on selected observation results, discussion and selecting questions, developing a hypothesis, conducting an investigation, collecting data, analyzing data, formulating a conclusion, and communicating findings, both oral and written. These activities give opportunities to students to enhance their ability to acquire scientific skills and to improve scientific attitudes leading to

HOTS. Knowledge can be gained from reading or listening, but skills and attitudes can only be improved through practices.

REFERENCES

- [1] D. Ismayanti, "The Ministry of Education and Culture regulation of Indonesia," *No. 22*, 2016.
- [2] S. Pusporini, Ashadi, and Sarwanto, "Pembelajaran Kima berbasis problem solving menggunakan laboratorium riil ditinjau dari gaya belajar dan kemampuan berpikir kritis siswa," *JURNAL INKUIRI*, vol. 1, pp. 1-6, pp. 34-43, 2012.
- [3] N. Fajariah, B. Utami, and Haryono, "Penerapan model pembelajaran inkuiri terbimbing untuk meningkatkan kemampuan berpikir kritis dan prestasi belajar pada materi kelarutan dan hasil kelarutan siswa kelas XI SMA AL Islam 1 Surakarta tahun ajaran 2014/2015," *Jurnal Pendidikan Kimia (JPK)*, vol. 5, pp. 89-97, 2016.
- [4] T. Pambudi, S. Mulyan, and C. S. A. Nugroho, "Pengaruh pembelajaran Kimia dengan model pembelajaran learning Cycle 5E menggunakan laboratorium real dan virtual ditinjau dari sikap ilmiah terhadap prestasi belajar siswa kelas XI MIPA SMA Negeri 3 Surakarta tahun ajaran 2014/2015," *Jurnal Pendidikan Kimia (JPK)*, vol. 5, pp. 78-87, 2016.
- [5] A. Rohmawati, Wijayanto, and S. Ridlo, "Analysis of 21st century of students on implementation project based learning and problem posing model in science learning," *Journal of Primary Education*, vol. 9, pp. 58-67, 2019.
- [6] I W. Subagia and I G. L. Wiratma, "The quality of Chemistry learning process viewed from learning outcome indicators and Process of Teaching," *Proceeding 2nd International Conference on Innovative Research Across Discipline (ICIRAD)*, Atlantis Press: Advances in Social Science, Education and Humanities Research, vol. 134, pp. 131-136, 2017.
- [7] M. T. Chandio, S. M. Pandiani and R. Iqbal, "Bloom's Taxonomy: improving assessment and teaching-learning process," *Journal of Education and Educational Development*, vol. 3, pp. 203-221, 2016.
- [8] Y. M. Heong, W. B. Othman, J. B. M. Yunus, J. T. T. Kiong, R. B. Hassan, and M. M. B. Mohamad, "The level of Marzano Higher Order Thinking Skills among technical education students," *International Journal of Social and Humanity*, vol. 1, pp. 121-125, 2011.
- [9] C. Chin and Osborn, "Student's questions: A potential resource for teaching and learning science," *Studies in Science Education*, vol. 44, pp. 1-39, 2008.
- [10] A. Hofstein, Q. Vavon, M. Kipnis, and R. M. Naaman, "Developing students' ability to ask more and better questions resulting from Inquiry-Type Chemistry laboratory," *Journal of Research in Science Teaching*, vol. 42, pp. 791-806, 2005.
- [11] I W. Subagia, "Implementasi pendekatan saintifik dalam Kurikulum 2013 untuk mewujudkan tujuan pendidikan nasional," *Prosiding Seminar Nasional FMIPA Undiksha*, vol 3, pp. 16-29, 2013.
- [12] I. Wardani and Djukri, "Teaching science process skill using Guided Inquiry model with Starter-Experiment-Approach: An experimental study," *PPBI (Jurnal Pendidikan Biologi Indonesia)*, vol 5, pp. 277-284, 2019.
- [13] N. Syila and G. Hodolli, "The teaching method named: Starter-Experiment-Approach," *Bulgarian Journal of Science Education*, vol. 26, pp. 807-812, 2017.
- [14] A. O. Bassey, T. Abang, and M. Iji, "Challenge and prospects of applying scientific methods in sociological and policy investigation," *International Journal of Emerging Trends in Social Science*, vol. 1, pp. 9-15, 2017.
- [15] T. Tofede, S. T. Haines, and J. L. Elsner, "Best practice strategies for effective use of questions as a teaching tool," *American Journal of Pharmaceutical Education*, vol. 77, pp. 1-9, 2013.
- [16] A. Pratono, S. S. Sumarti, and N. Wijayati, "Contribution of Assisted Inquiry model of E-Module to students science process skill," *Journal of Innovative Science Education*, vol 7, pp. 62-68, 2018.
- [17] H. E. Abungu, M. I. O. Okere, and S. W. Wachanga, "The effect of science process skills teaching approach on secondary school students achievement in Chemistry in Nyando District, Kenya," *Journal of*

- Educational and Social Research, vol. 4, pp. 359-372, 2014.
- [18] A. Oguz, and K. Yurumenzoglu, "The primacy of observation in Inquiry-Based science teaching," 2007.
 - [19] H. R. Widarti, A. Permanasari, and S. Mulyani, "Student misconception on Redox Titration (A challenge on the course implementation through cognitive dissonance based on the multiple representations)," *Jurnal Pendidikan IPA Indonesia*, vol. 5, pp. 56–62, 2016.
 - [20] C. S. Lammer Heindel, "Facts and opinion," Loras College, Dubuque, Iowa, USA, 2016.
 - [21] I W. Subagia, I G. L. Wiratma, and I N. Selamat. "Teacher's handicap in conducting learning process using scientific approach: a case analysis of in-house training results of senior high school teachers," *Journal of Physics: Conference Series*, 1317012154, pp 1-6, 2019.